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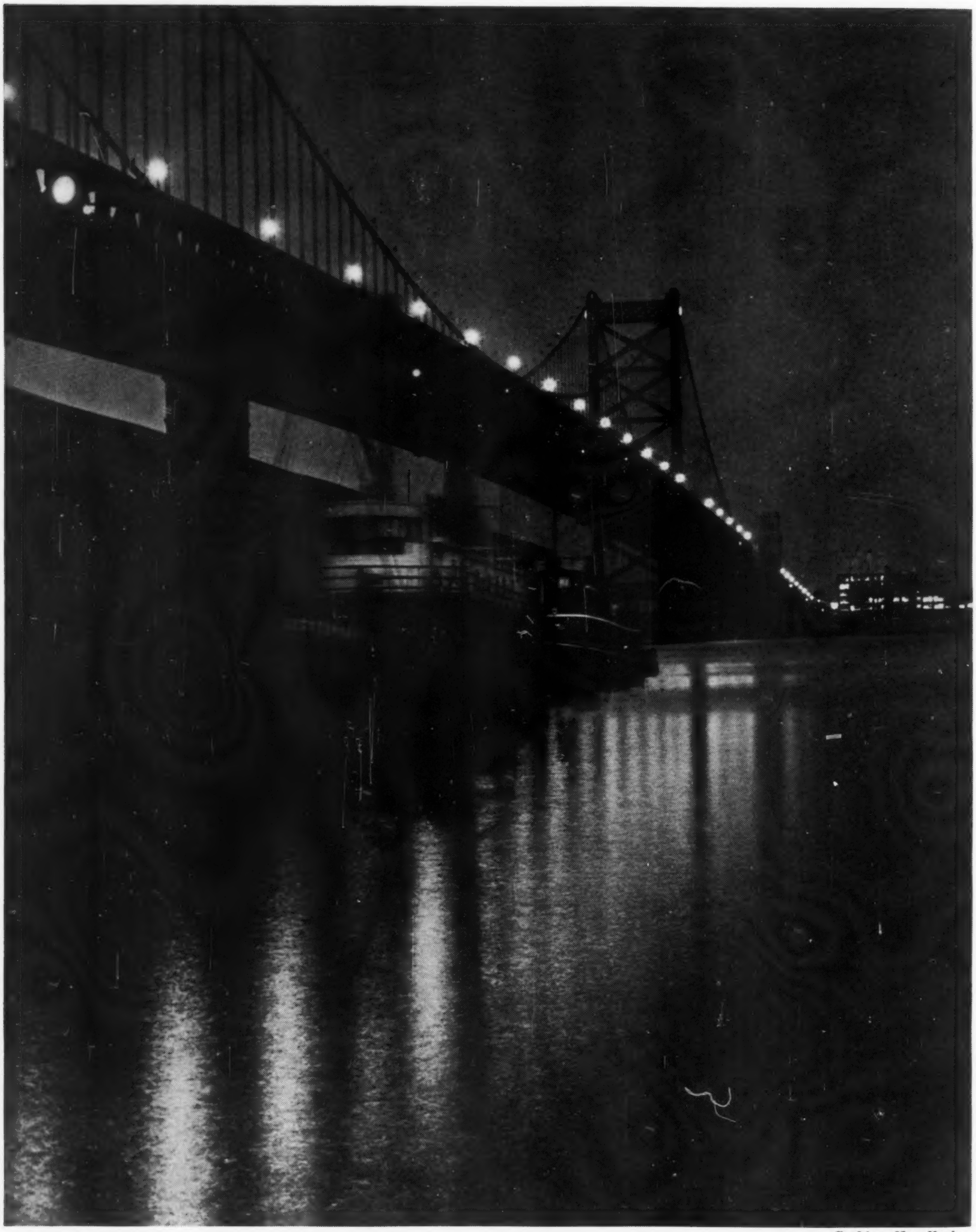

Cushing, New York

Suspension Bridge Over Delaware River Between Philadelphia and Camden

(A.S.M.E. Sixtieth Annual Meeting will be held at Hotel Bellevue-Stratford, Philadelphia, Pa., Dec. 4–8, 1939. See pages 931–933.)

VOLUME 61
No. 12

MECHANICAL ENGINEERING

DECEMBER
1939

GEORGE A. STETSON, *Editor*

Accent on Quality

IF JUSTIFICATION were needed for the space devoted this month to engineering education in the story of the E.C.P.D. annual meeting and the review of D. C. Jackson's report, both of which appear in this issue, it would be possible to point to the coincidence of the meeting with the appearance of the report. Beyond this coincidence, however, looms the fact that the subjects to which both the meeting and the report were addressed are of extreme importance to the engineering profession. In the opinion of many able persons world and domestic affairs pose problems and generate an atmosphere of change that call for carefully studied decisions. An awakening to consciousness of what is going on in the world that raises these problems and demands these decisions leads to repetitions of discussion justified by the fact that it may ultimately result in a crystallization of opinion and a desire to work constructively toward higher quality in the engineering profession, or at least to view attempts by others in this direction with sympathetic understanding.

Accent is on quality in the Jackson report and in the deliberations of the E.C.P.D., quality of a high order in all that concerns selection, education, professional experience, and practice of engineers and services rendered to the common welfare by them. The need for high quality begins with the educational process and continues through all agencies that contribute to that end outside the educational institutions themselves—engineering societies and publications, for example—into the actual practice of engineering principles in reshaping a better world and maintaining the superior position of the United States in the World of Tomorrow.

Emphasis must be laid principally on education and early training, and the institutions that foster both by organized activities, because the pattern of the immediate future must be woven of the lives and characters of young men, even though the design may be provided by older men. Disinterest cannot be condoned because the diploma is won or the license to practice acquired. To what purpose are young men trained if they are to find outside the university environment an atmosphere of thoughtless indifference and a technological monasticism isolating engineers from the larger concerns of their fellow men? Fortunately, the very fact that thousands of engineers have organized to advance their common interests through the medium of engineering societies is proof that this indifference does not exist in a large sector of industrial life; but this group is pitifully small when it is compared with the great army of workers through whom young men make their first contacts with bread-and-butter existence. Accent on quality serves to build a profession that will not only bring greater rewards and satisfaction to those who practice it but also one that can meet the heavy obligations to the nation and the public that developments in a rapidly changing world entail.

Significant Trends

FROM the Jackson report and the discussions at the E.C.P.D. meeting, significant trends in engineering education are seen that bear on the accent on quality. Education on the college level, which used to be the privilege of a few, has become, since the World War, the right of the many. The college-trained man is no longer in competition with a mere handful of others similarly privileged. Wherever he goes he is in competition with men who have had the same training as his. Education at public expense has raised the relative number of educated persons in the country, but it has also resulted in spending a lot of public money on young people, and not always wisely. The young person who is to succeed must demand a high quality of education because of increased numbers educated at colleges, but the public, the professions, and the colleges must insist on conserving their funds for the education of the men best fitted to benefit and assume the responsibilities laid on them by the investment in their education.

As a result of these conditions, we see in engineering education, which demands superior students and requires heavy expenditures, and in the engineering profession itself, a trend toward better selection of engineering students, insistence on faculties of higher quality and on proved teaching ability, better equipment, and more efficient absorption of the fruits of college training by graduates.

Growing emphasis on research, not only that undertaken by the permanent staffs of educational institutions but by undergraduates as well, is one of the hopeful trends of the present. The spirit and the methods of research are widely applicable. They are basic to the engineering technique. They are not confined to special laboratories working on the technical developments of future products or on the frontiers of scientific knowledge. They are demanded in every task in engineering and industry. While the professional research scientist may have particular genius and skills, all grades of engineers need to be imbued with the spirit of research and to know its methods. Hence the trend to provide means by which engineering students can observe and

participate in active research is gratifying and should be encouraged.

Because of the increasing dependence of engineering on applied science, its broadening field of activity, and the needs of industry for more thoroughly trained men, the lengthening of the engineering curriculum has long been agitated. Ways to accomplish this seem to have been narrowed to providing opportunities for graduate study for a growing number of the best-qualified men. Industry, which used to fear overtraining, has become convinced of its need for men with more than undergraduate education. The schools have responded by offering more opportunities for graduate work. The danger in the situation, if there is any, lies in the possibility that experience, best and sometimes only obtainable in practice, may be too lightly regarded. The responsibility for safeguarding this situation rests less on the schools than it does on industry and the engineering profession.

By means of the E.C.P.D., the engineering profession, through the engineering societies, is attempting to coordinate and give direction to efforts to make more effective the immediate postcollegiate experiences of young engineers. The task is hardly begun. Some possibilities are being explored and some experiments undertaken. But the field is largely uncultivated. For engineering societies to exhort colleges and industry to better efforts in education and professional training would savor of impertinence were these societies to sit back and leave their own responsibilities and opportunities untouched because they were not comprehended. Thus the trend in education toward greater cooperation between the societies and the schools, through student branches of the societies, for example, is significant. The task lies in our own dooryard.

No subject has given rise to more discussion recently than what may be termed the liberalization, or humanization, of engineering education and the engineering profession. The trend is no less significant because its direction is obscure. What is generally meant by these terms is an awakening to the point of actively doing something about broadening the content of the engineering curriculum and instilling in engineering students and practitioners as well a better understanding of the world in which they live, the problems this world faces, and the obligations educated men, and perhaps particularly engineers, have in performing their civic and professional functions. It is not clear to the colleges what they can and should do about it. Swings of the cycle from specialization to generalization are nothing new. If there is a significant trend in this field it is in attempts to increase the benefits of a broad general education without shifting emphasis from the main purpose of such institutions to train competent engineers who are, in the very nature of things, specialists. Substitution of so-called "cultural," "liberal arts," or "academic" courses for engineering courses or practical experience is not a satisfactory solution. If the tendency to spend more years in school before entering a career for self-support persists in the pattern of our national economy, because the need or opportunity for fewer workers and the possibility of enjoying more "leisure" persist, a lengthened curriculum may provide part of the solution. But not all; for there still remains the question of timing. It must still be determined whether engineering and nonengineering courses should be parallel stems, extending throughout the educational experience and skillfully coordinated, or whether one should precede the other, and if so, whether one school or more should undertake to furnish the instruction. This important and significant trend is being studied by educators and members of the profession and its proper direction and control will have far-reaching effects.

Accent on Quantity

REFERENCE has already been made to the growing number of college-trained men. This accent on quantity has its hazards. Not every man is endowed by nature to develop into an engineer of high quality. Misfits are misfortune. Opportunity exists for satisfying careers at subprofessional levels. Technicians are needed in a world wedded to applied science. Hence the tendency of technical institutes to develop into degree-granting colleges robs the country of opportunity to provide needed training for thousands of young men. Perhaps the country needs the accent on quantity provided by the increase in the number of degree-granting schools. But it certainly needs the technical institutes.

Columbia's Birthday

AS A PART of its program commemorating the seventy-fifth anniversary of the founding of what is now its School of Engineering, Columbia University, during the first week of November held an "Open House" to which the public in general was invited. Inside the buildings that form the impressive group on Morningside Heights visitors were introduced to the workmanlike laboratories where the assault on the unknown which marks the technique of research is being conducted. How much the average visitor understood of what he saw cannot be judged. Probably the collapse of an eight-foot brick wall in a two-story testing machine meant something, but even the name "barodynamic research" must have added mystery to a rapidly revolving miniature model mine roof with props of paper collapsed under the effects of centrifugal pressure. The lay ear could appreciate the superior quality of staticless radio reception, but measuring the friction of an invisible film of lubricant three molecules thick probably registered only with the engineers and scientists. To one observer the most striking features of the exhibits, aside from their variety, were the fruitfulness of the technique of testing miniature models, prototypes of enormously larger structures, and the many devices by which hidden effects are made visible, audible, and measurable. A few hours spent in such laboratories as those at Columbia reaffirms faith in man, and by contrast magnifies the gulf between his rational powers and his emotional weakness.

Progress in RAILWAY MECHANICAL ENGINEERING, 1938-1939

Moderate Recovery Experienced—Technical Improvements in Locomotives and Cars Noted

THE ANNUAL SURVEY, which is presented to the Railroad Division by Committee RR6, covers the calendar year, September 1, 1938, to September 1, 1939. It is probable and desirable that there will be some overlap with last year's report and that of next year on matters of general interest, and items from abroad will of necessity lag some weeks further behind.

In general, this twelve-month period represents one of measured recovery from the recession of last year in the lines in which we are most interested in our own country, and a period of moderate activity abroad. The year has seen the construction of a spectacular new-type steam locomotive of what may be termed conventional design; an excursion into the field of turboelectric-locomotive operation, in part the result of several years' experiment and preparation and in part bold pioneering. It has seen the already somewhat conventionalized 1800-hp Diesel-electric motive power unit raised to the 2000-hp level both in single and multiple units. During the year, all previous maxima in terms of power of a single locomotive have been exceeded in a Swiss electric locomotive of 12,000 hp. The Dieselization of passenger service in Europe has continued. Domestic passenger cars show every increasing refinement both in the sleeper class and in coaches. Three more notable de luxe all-coach trains have been put into service. The fleet of lightweight full-strength coaches and sleepers has been substantially augmented during the year. The battle of the American railroad against deadweight in car construction continues not only in the field of passenger-service cars, where car weights and train weights have been proved susceptible of 25 per cent reduction without sacrifice of strength, but also in the freight car field, where weights are being progressively scaled down, not for the purpose of reducing train weight but of increasing the proportion of this weight which shall be "pay load."

AMERICAN STEAM-LOCOMOTIVE CONSTRUCTION

The outstanding example of steam-locomotive construction for the year is the engine, *American Railroads*, built by the Pennsylvania Railroad with the collaboration of engineers of the Baldwin, American, and Lima companies. This engine was designed to handle trains of 1200 tons maximum at speeds up to 100 mph. Practically every detail of the construction is a superlative, representing new attainments in total weight, power, speed, and detail design for a passenger engine. At the same time, it is necessary to recognize that to a considerable degree the locomotive is experimental; its adaptability for the service for which it was designed has not been fully determined, since it was placed on exhibition at the New York World's Fair after a limited number of breaking-in runs. The dimensions of the locomotive are given as Item 1 of Table 1, and Fig. 1 shows a general view. It is of interest to compare this locomotive with two others; namely, with the B.&O. No. 5600 of the same general construction but much smaller, and with the most recent articulated freight locomotive:

	American Railroads, No. 6100	*George Emerson*, No. 5600 B.&O.	No. 3706 D.&R.G.W.
Wheel arrangement..........	6-4-4-6	4-4-4-4	4-6-6-4
Total wt of locomotive, lb...	608170	386500	641900
Wt on drivers, lb............	281440	238000	437930
Cylinders (4 per engine), in..	22 × 26	18 × 26 1/2	23 × 32
Diam of drivers, in..........	84	76	70
Working press, lb per sq in..	300	350	225
Rated tractive force, lb.......	76400	65000	105000
Type of boiler...............	Modified Belpaire	Emerson	Radial-stay
Smallest outside diam, in.....	93	80	94 1/2
Tube length, ft..............	22	25	22
Combustion chamber, ft-in...	9-5	..	9-11
Grate area, sq ft.............	132	80.5	136.52

The first two locomotives are nonarticulated; the four cylinders are integral parts of a single bed casting for each locomotive. In the case of the Pennsylvania engine, each pair of cylinders is ahead of the four drivers which it serves, while the B.&O. engine has the rear pair of cylinders under the front end of the firebox, a construction made possible by the Emerson water-tube firebox used. Advantages and disadvantages of each arrangement are obvious. The D.&R.G.W. locomotive is articulated, using the familiar Mallet construction with a hinge joint between the frames, requiring flexible piping to carry high-pressure steam to the front cylinders and a flexible exhaust line as well. Sufficient flexibility on curves for the two nonarticulated locomotives is secured by the use of lateral-motion boxes on the first and third drivers of the Pennsylvania engines and on the first and fourth axles of the B.&O.

Among many unique features of the construction of the 6-4-4-6 are the 78-ft 48-ton engine-bed casting, the extreme length of the combustion chamber, a boiler center height of 132 3/4 in., very short connecting rods, six-wheel leading and trailing trucks, the former with three-point suspension, 1 1/8-in. eccentricity between the main journal and the main side journal on the crankpins, and 660 sq ft of firebox heating surface.

At the New York World's Fair, the locomotive, *American Railroads*, is mounted on an "exhibition plant." This consists of a set of axles spaced identically with those of the locomotive; on each axle is mounted a pair of wheels having a rim which conforms to the shape of a rail-head. When steam is turned into the cylinders, the driving wheels rotate, the respective supporting units for the two sets of drivers being belted together so that the rotation is at the same speed. Further, the wheels of the leading truck and trailing truck are caused to revolve by other belt connections. The tender wheels rotate on similar supporting units, one axle in each unit being driven by a

Report of Committee RR6, Survey, for presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Philadelphia, Pa., Dec. 4-8, 1939. Report prepared by the Chairman, E. G. Young, with the cooperation of the members of the Committee, Messrs. B. S. Cain, John Roberts, K. F. Nystrom, and A. Giesl-Gieslingen.

TABLE 1 DOMESTIC STEAM LOCOMOTIVES

Item No.	Owning Road	Builders	Type	Weight in 1000's: Total Engine	Weight in 1000's: Drivers	Weight in 1000's: Tender	Cylinders: No.	Cylinders: Size	Evaporating Surface	Superheating Surface	Tube Length (ft.-in.)	Working Pressure	Diameter of Drivers	Grate Area	Tractive Force
1.	Pennsylvania	Penna.	6-4-4-6	608	281	452	4	22×26	5661	2085	22'-0"	300	84	132	76,400
2.	C.M.St.P.&P	A.L.Co.	4-6-4	415	216	375	2	23½×30	4166	1695	19'-0"	300	84	96.5	50,300
3.	Canadian Pacific	Mont.L.W.	4-6-4	363	187	289	2	22×30	3791	1542	18'-3"	275	75	80.8	45,200
4.	Lackawanna	A.L.Co.	4-6-4	377	198	313	2	26×30	3854	1123	17'-6"	245	80	81.5	52,800
5.	Richmond-Washington	B.L.W.	4-8-4	407	260	282	2	27×30	4289	1325	20'-0"	260	77	86.5	62,800
6.	Southern Pacific	Lima	4-8-4	460	267	373	2	26×32	4887	2086	21'-6"	280	80	90.4	62,800
7.	Grand Trunk Western	Lima	4-8-4	382	238	279	2	24×30	3852	1530	21'-10"	275	77	73.7	52,500
8.	C.M.St.P.&P.	B.L.W.	4-8-4	490	282	397	2	26×32	5509	2336	21'-0"	285	74	106	70,800
9.	Denver & R.G. Western	B.L.W.	4-8-4	479	279	394	2	26×30	5506	2336	21'-0"	285	73	106	67,200
10.	Union Pacific	A.L.Co.	4-8-4	483	270	407	2	25×30	4470	1900	19'-0"	300	80	100.2	63,800
11.	Wheeling & Lake Erie	A.L.Co.	2-8-4	408	260	365	2	25×34	4718	1924	19'-0"	245	69	90.3	64,100
12.	Canadian Pacific	Mont.L.W.	2-10-4	447	310	284	2	25×32	5054	2032	20'-11"	285	63	93.5	76,900
13.	Denver & R.G. Western	B.L.W.	4-6-6-4	642	438	394	4	23×32	6341	2628	22'-0"	255	70	136.5	105,000
14.	Southern Pacific	B.L.W.	4-8-8-2	658	532	393	4	24×32	6468	2616	22'-0"	250	63½	139	124,300

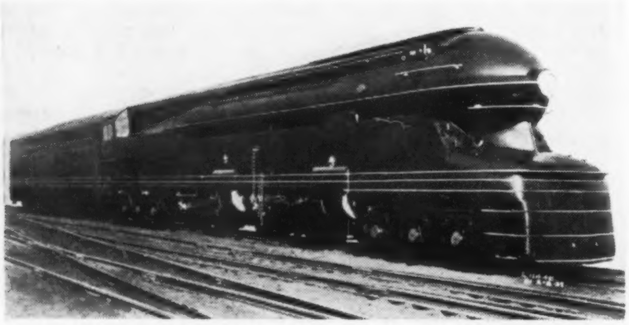

FIG. 1 *American Railroads*, 6-4-4-6 LOCOMOTIVE

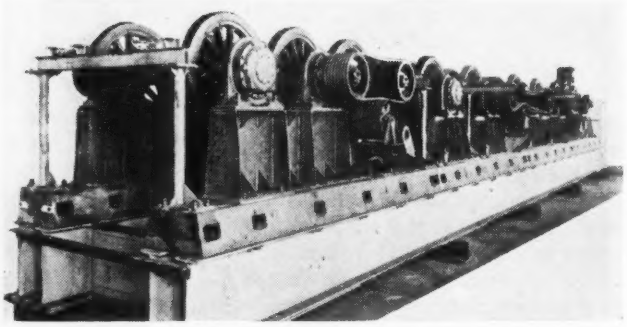

FIG. 2 EXHIBITION PLANT FOR ENGINE, *American Railroads*

TABLE 2 FOREIGN STEAM LOCOMOTIVES

Item No.	Railway	Gauge	Type	Builder	Weight in 1000's: Total Engine	Weight in 1000's: On Drivers	Weight in 1000's: Tender	Cylinders: Number	Cylinders: Simple or Compound	Cylinders: Size (diameter x stroke) inches	Working Pr.	Driver Diam.	Evaporating Surface	Superheating Surface	Grate Area	Tractive Force	Service
1.	London, Midland & Scottish	56.5	462	Ry	242	150	126	4	S	16¼×28	250	81	2807	856	50	40,000	Passenger
2.	Great Southern (Ireland)	60	460	Ry	187	141	114	3	S	18½×28	225	79	1870	468	33.5	33,000	Passenger
3.	Victoria (Australia)	56.5	282	Ry	230	166	184	2	S	22×28	205	61⅝	2583	540	42	38,700	Freight
4.	Commonwealth Ry. (do)	56.5	460	Walker			271	2	S	23×26	180	69	1990	650	30.5	30,500	Passenger
5.	Reichsbahn	56.5	482	Krupp	322		183	3	S	20½×28¾	284	78¾	3109	1425	54.2	54,830	Passenger
6.	B.A.G.S. (Argentine)	60	480	Vulcan	200	148	175	2	S	19½×28	225	68	1740	428	32.6	30,000	Mixed
7.	B.A.G.S. (Argentine)	60	462	Vulcan	198	121	175	2	S	19×28	225	72	1740	428	32.6	27,000	Passenger
8.	South African Railways	42	482	N.B.L.C.	244	162	153	2	S	24×28	210	60	3414	661	62.5	48,000	Mixed
9.	South African Railways	42	482+284	Beyer	394		—	4	S	20½×26	200	54	3050	770	63.4	68,400	Beyer-Garratt
10.	Araraquara Ry. (Brazil)	Meter	4-10-2	Berlin L.C.	240	179	108	2	S	22⅞×24	250	50	3110	1150	66.7	53,000	Mixed
11.	Abidjan-Niger	Meter	482+284	Société Franco-Belge	334	204	—	4	S	17×24	200	51	1991	258	47	44,660	Mixed
12.	Malay States Rys.	Meter	462	NBLC	130	86	96	2	S	13×24	250	54	1109	218	27	23,940	Passenger

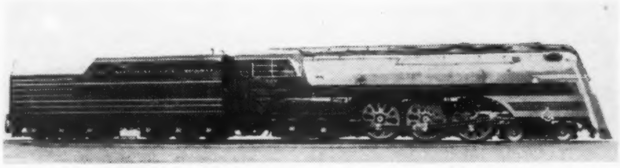

FIG. 3 HUDSON TYPE LOCOMOTIVE FOR MILWAUKEE

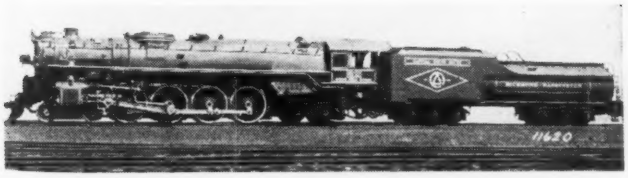

FIG. 4 RICHMOND FREDERICKSBURG AND POTOMAC 4-8-4 LOCOMOTIVE

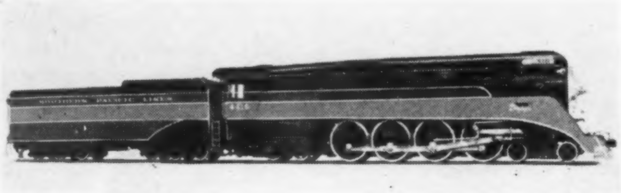

FIG. 5 SOUTHERN PACIFIC 4-8-4 LOCOMOTIVE

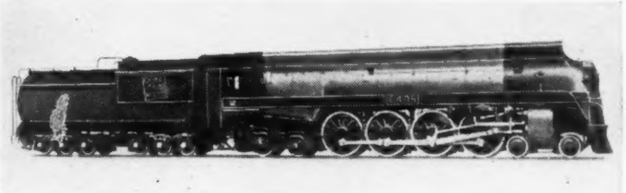

FIG. 6 GRAND TRUNK WESTERN 4-8-4 LOCOMOTIVE

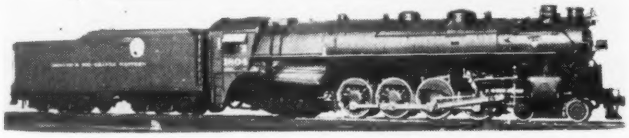

FIG. 7 DENVER & RIO GRANDE WESTERN 4-8-4 LOCOMOTIVE

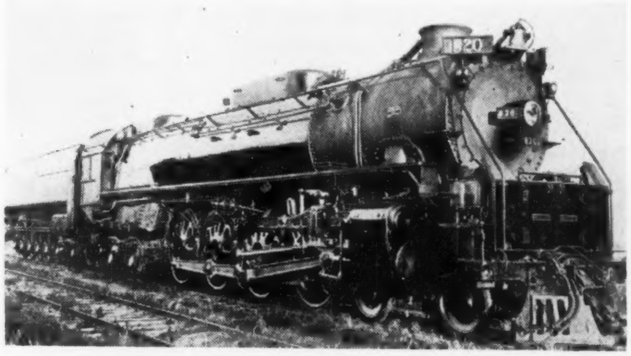

FIG. 8 UNION PACIFIC 4-8-4 LOCOMOTIVE

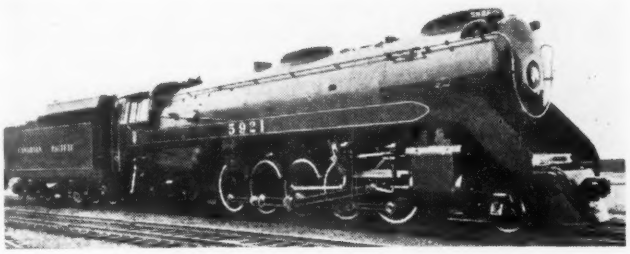

FIG. 9 CANADIAN PACIFIC 2-10-4 LOCOMOTIVE

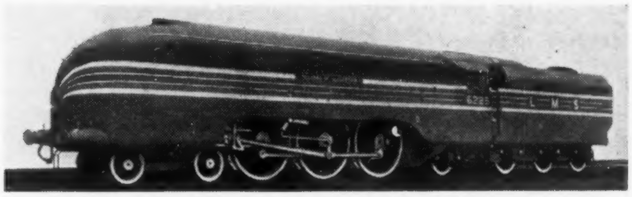

FIG. 10 *Coronation Scot*, 4-6-4 LOCOMOTIVE

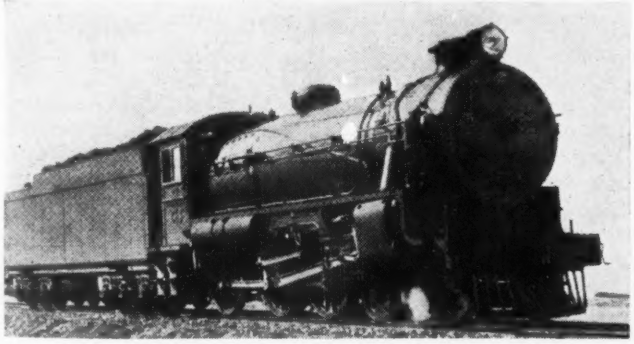

FIG. 11 AUSTRALIAN COMMONWEALTH 4-6-0 HEAVY TENDER

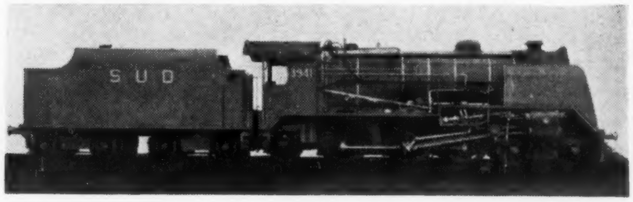

FIG. 12 ARGENTINE SOUTHERN 4-6-2 LOCOMOTIVE

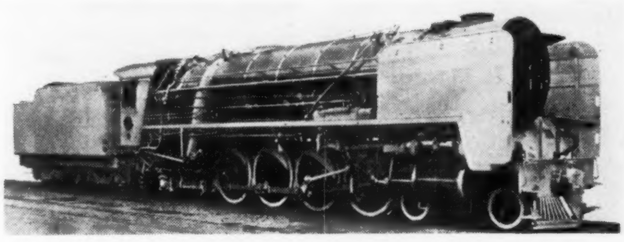

FIG. 13 SOUTH AFRICAN RAILWAYS 4-8-2 LOCOMOTIVE

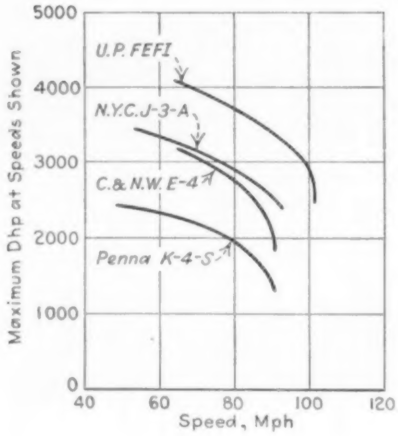

Fig. 14

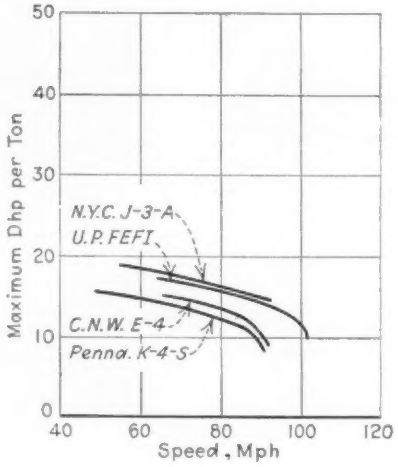

Fig. 15

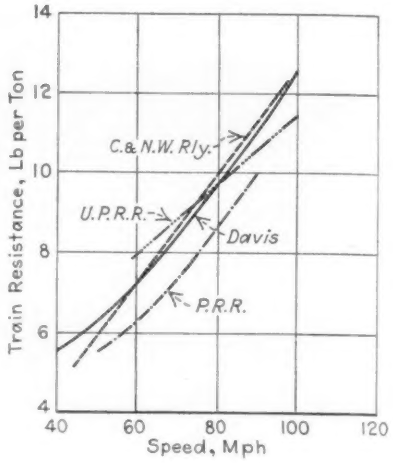

Fig. 16

FIG. 14 A.A.R. PASSENGER-ENGINE TESTS; MAXIMUM DRAWBAR HORSEPOWER

FIG. 16 TRAIN-RESISTANCE CURVES COMPARED WITH DAVIS FORMULA

FIG. 15 A.A.R. TESTS; HORSEPOWER PER TON OF ENGINE WEIGHT

$$R = 1.3 + \frac{29}{W} + 0.03V + \frac{0.041V}{Wn}$$

R = resistance, lb per ton
W = avg weight per axle, tons
n = number axles per car
V = speed, mph

railway-type motor, which takes current from generators belted to the driving-wheel supporting axles. The entire supporting arrangement is set level with the normal rail surface and covered with plates, so that the action of the locomotive on ordinary track is simulated as closely as possible. In Fig. 2 the main elements of the supporting arrangement are shown.

Other American engines built within the last few months are also included in Table 1. The second item in the table is the 4-6-4, built by the American Locomotive Company for the Milwaukee. These engines are used both for the *Hiawatha* service and as needed on other trains. They have operated at speeds up to 105 mph and are reported to have a maximum of 120 mph to their credit. The cabs are of particularly interesting design, the wide-vision windows having caused one writer to remark: "The cab is a cross between a parlor car and a conservatory."

The Canadian 4-6-4's and 2-10-4's, are developments of already standard types, moderately streamlined. The *Royal* train on the C.P.R. was handled by one of the Hudson-type locomotives. The Grand Trunk Western 4-8-4 shared *Royal* train honors. This engine represents the lighter group of this popular type with the Milwaukee 4-8-4 at the opposite extreme, a difference in cylinders from 24 × 30 in. to 26 × 32 in. and 108,000 lb difference in weight. A representation of the year's construction requires that 6 out of the 14 items in the table be of this wheel arrangement. Items 13 and 14 represent continued satisfaction with the results secured from the articulated simple locomotive in heavy mountain service. Items 2, 5, 6, 7, 9, 10, and 12 are illustrated in Figs. 3 to 9, inclusive.

FOREIGN STEAM LOCOMOTIVES

Several foreign steam locomotives of generally conventional design are listed in Table 2 and illustrated in Figs. 10 to 13. The first engine listed is the *Coronation Scot*, mentioned last year and here included because of its visit to the New York World's Fair. This engine has copper firebox sheets with flues screwed into the tube sheet before expanding; all stays are of monel metal. Item 2 is a conventional wide-gage, 3-cylinder 10-wheeler for heavy passenger service in Ireland. The similarity of Australian construction to American engines becomes more and more striking as the former gain in weight and power. Item 3 has 9000 lb additional tractive force in its booster. Item 4 is the first case which has come to the author's attention of a tender weighing more than a locomotive.[1] Items 6 and 7, British construction for the Argentine, show the same boiler fitted to 4-8-0 running gear for freight, and to 4-6-2 running gear for passenger service. The 4-8-2's of item 8 are in one of three different classes with this wheel arrangement recently placed in service. Items 1, 4, 7, and 8 are illustrated. Items 10 and 11 show the continued purchase of the Garratt type for African service, especially on heavy-traffic narrow-gage lines. Item 12 is an example of "maximum" design in minimum compass. These little Pacifics follow the standard practice of the Malay States railways in using rotating-cam poppet valves.

STEAM-LOCOMOTIVE TESTS

The year has brought the publication of a considerable volume of test results on various phases of locomotive operation. Most notable among these from the American standpoint are the Association of American Railroads (A.A.R.) passenger-engine tests which are the result of a need for further information on the subject of power requirement at high speeds. The Committee on the Further Development of the Reciprocating Steam Locomotive was authorized to conduct tests on a train of 1000 tons weight to determine the power required to produce and maintain a speed of 100 mph. These tests were carried out on the Pennsylvania, Union Pacific, and Chicago & North Western lines, with the same train of 16 coaches. Train-resistance records were kept and the resistance on the three lines was found to be such that the well-known Davis formula gives a very satisfactory basis for estimation, with reasonable conservatism at high speeds. A speed of 100 mph was actually obtained only on the Union Pacific, on a slightly descending grade. Figs. 14 and 16 show the curves published in the report on the tests, the maximum drawbar-horsepower curves and resistance curves being assembled for comparison. Fig. 15

[1] Weights for the locomotive in this case are not available, but will not exceed 200,000 lb.

shows the same curves reduced to horsepower per ton of locomotive weight. It is a matter for regret that the only specific results which can be obtained directly from the test data are those for resistance of the train. The tests produced no information on the subject of locomotive resistance, steam consumption, or firing rates, except that it was evident the steam supply was ample at all times. Consequently, studies made in the report of the requirements in power for certain accelerations and maximum speeds are all based on assumptions of speed factors.

The report takes up at length the distance and time required for accelerating a train to 100 mph speed on the basis of the actual test data and assumed "improved" performance, showing for example with a locomotive developing a maximum of 5000 hp normal performance, it would take 29 miles for a train to be accelerated from 80 to 100 mph, with the power available at those speeds.

In plotting the results of the A.A.R. tests, figures for tests on a similar train hauled by the New York Central J3a have also been included. These figures were made available to the A.A.R. Committee on the Further Development of the Steam Locomotive some months earlier than the series of tests on the three railways. The principal dimensions of the four locomotives are as follows:

Railroad	U.P.	C.N.W.	Penna.	N.Y.C.
Wheel arrangement	4-8-4	4-6-4	4-6-2	4-6-4
Class or designation	PEFI	E4	K4s	J3a
Cylinders, in	$24^1/_2 \times 32$	25×29	27×28	$22^1/_2 \times 29$
Drivers, in	77	84	80	79
Working pressure, lb per sq in	300	300	205	275
Weight of locomotive, lb	465000	412000	320000	360000
Total (combined) heating surface, sq ft	6070	5863	4984	5932
Grate area, sq ft	100	91	70	82

French Experiments. In 1936 the French railways started experimenting with the substitution of the Brown-Boveri Velox steam generator for the boiler on an otherwise conventional engine. During the present year the installation has been finally worked out to the point of placing the locomotive under regular service test in the Southeastern region of the French system.

The arrangement of the Velox generator permits the enginemen's cab to be located at the head end, and facilitates streamlining. This has been done in the present case but no change whatever has been made in the cylinders or running gear. The Velox generator is said to deliver one third more steam than was obtainable from the boiler which it replaced; it is designed for an output of 27,000 lb of steam per hour at 285 lb per sq in. pressure and 700 F temperature.

The principle of the Velox boiler is as follows: Oil is burned in an enclosed combustion chamber at a pressure of about 35 lb per sq in. This pressure permits the liberation of a very great amount of heat in a limited space and serves also to force the burned gases or products of combustion along the evaporator and superheater tubes, which surround the combustion chamber, at a very high rate of speed. The coefficient of heat transmission is greatly increased due to this high gas speed and the required heating surface correspondingly reduced. A turbine-driven air compressor produces the necessary combustion-chamber pressure at small cost in steam. The air compressor may be driven either by steam or electricity for starting. Water circulation is maintained by a pump which continually forces through the tubes a much larger amount of water than can be evaporated. There is thus returned to the separator a water-steam "emulsion," which is tangentially injected into the separator, the resulting centrifugal force causing the water to fall to the bottom of the separator. Regulation of boiler

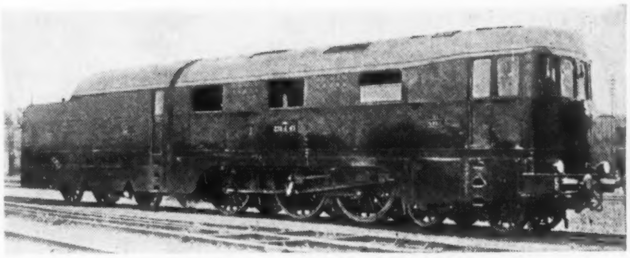

FIG. 17 LOCOMOTIVE WITH VELOX BOILER

output to correspond to cylinder steam demand is obtained by three automatic regulations. The fuel supply to the combustion chamber is governed by the pressure of steam leaving the superheater, any pressure drop causing an increase in the firing rate, and vice versa; a second regulator controls the air-oil mixture so as to provide a sufficient supply of air at all times; the third regulator adjusts the feedwater valves under the control of the water level in the separator.

The work with the Velox boiler is one of several experiments, either in preparation or already under way on the French lines, which involves radical innovations. The general appearance of the Velox engine is shown in Fig. 17.

British Tests. The results of tests on a locomotive of the *Coronation* class, identical with that of the *Coronation Scot* train but nonstreamlined, have been published. This locomotive was given an overload train between Crewe and Glasgow and run on a schedule corresponding to that of the *Royal Scot*, requiring an average speed for the 244 miles in each direction of 55 mph. The locomotive took its 680-ton train over two summits involving long grades in excess of 1 per cent within this schedule. Indicated horsepowers of 3200 or slightly greater were maintained for a speed range from 44 to 70 mph, and 2500 drawbar horsepower was sustained at 65 mph. Comparison of these tests with the New York Central J3a, already referred to, is of special interest. The latter locomotive has developed 4700 ihp at 80 mph and 3880 drawbar horsepower at 65 mph: These, it will be noted, exceed the British results precisely in proportion to the 50 per cent excess weight of the American locomotive.

Counterbalance Tests. The increase in wheel loads, cylinder thrust, and speed in recent years has combined to focus attention on the counterbalance problem, as it relates to the desirable fraction of the reciprocating weight which should be balanced in relation to the deformation of rails and the lifting of the driving wheels as a result of dynamic augment. In the early part of the year results of tests carried out by the Burlington and the Timken companies on Burlington equipment were published. These and other analogous tests have greatly increased the available knowledge of counterbalance action, but in general have opened the way and indicated the need for additional study. In the tests reported, the action of the locomotive main axle was studied in its relation to the spring of the rails or track resilience, and the degree of overbalance in the driving wheel. Calculation by means of formulas for resilience indicated that the wheel would be "bounced off the track," in every engine tested, at a speed considerably lower than that at which the centrifugal force would lift it. In the case of locomotives with standard reciprocating parts and heavy overbalance in the wheels, actual lifting speed corresponded closely with the centrifugal force; for the locomotive with considerably less overbalance the lifting began at speeds well below the critical speed for centrifugal-force lifting, but higher than the "bounce" speed.

The report pointed out the common error in balancing the main rod, resulting in unintended excess balance of 78 to 131 lb in the locomotives tested.

The high speeds of rotation (up to 164 mph) in these tests were obtained with maximum track speeds of about 80 mph, and greased rail. It remains to be proved that the counterbalance action under such conditions is sufficiently similar to that when the roadway is actually traversed at the rotational speed, that slipping-test results will not have to be discounted on account of some difference in track resilience conditions. An exceedingly interesting discovery from the tests was that, contrary to expectation, the wheel did not rise and return to the rails during a few degrees while the counterbalance was at the top quarter, but was actually off the rail for two thirds of the revolution. Another important observation was that even though there is a definite lift as proved photographically, the locomotives with light overbalance did not damage the rails. Further evidence of the intense current interest in the counterbalance problem was developed in a symposium program before the Western Railway Club in March. From the track-maintenance standpoint, the characteristic form and amount of damage due to improperly balanced locomotives on high-speed passenger trains was presented, with the appeal to the mechanical department to provide locomotives balanced in a manner suited to current speed demands. From the locomotive standpoint, the bad effects of the tendency to overbalance the main driver were shown, also the improved conditions obtained in a specific case by reducing the main balances.

Extensive counterbalance tests on passenger locomotives in India of both standard and narrow-gage classes were undertaken to study the action on track and bridges of varying amounts of reciprocating balance. The tests were mainly for study of the vertical effects of overbalance and observations of fore-and-aft effect were purely subjective. It was nevertheless stated that locomotives from whose wheels all reciprocating compensation had been removed ran steadily at all speeds and these engines were returned to service with "nil reciprocating balance."

DESIGN AND CONSTRUCTION DETAILS

Poppet-Valve Gear. The Franklin Railway Supply Company has developed and is offering a poppet valve and gear suitable for the large cylinders and high steam pressures in current American locomotive practice. Poppet-valve gears as developed abroad are of two general types, i.e., the oscillating-cam type and the rotary-cam type. The rotary type is driven by gearing from the locomotive axle, and permits separate control of the admission and exhaust valves, but only as many different control points for each as there are provided cam surfaces or profiles. The number of operating cutoffs which can be used is therefore limited to from four to six at the most. The oscillating type has the advantage of being driven by a familiar type of valve gear, but the admission and exhaust events cannot be separately controlled. The Franklin gear has been developed in the effort to obtain the advantages of both types as far as possible in a mechanism suited to conditions in this country. Fig. 18 shows a laboratory installation of this gear.

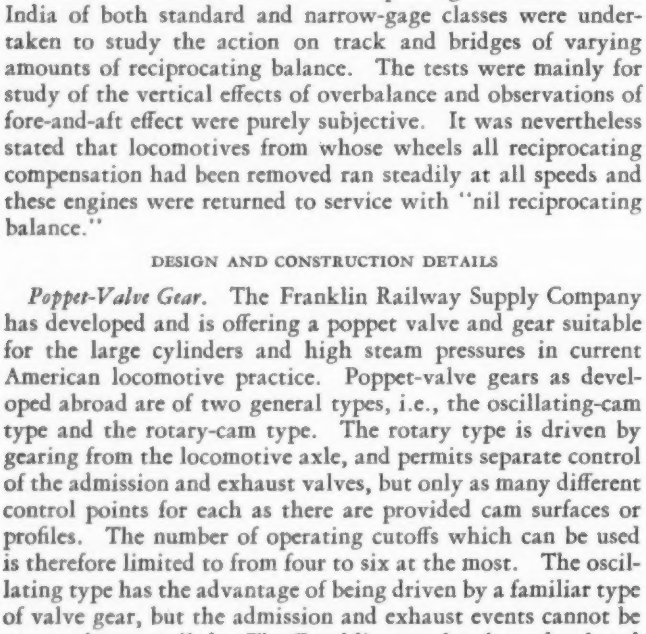

FIG. 18 LABORATORY INSTALLATION OF FRANKLIN POPPET-VALVE GEAR

The unit consists of a gearbox which takes the place of the parts of the normal valve gear, the cam box, and the steam chests in which the valves are installed. The gearbox drive is from the crossheads on either side. Each crosshead, through a union link and a connection similar to the Walschaerts combining lever, rotates a shaft passing through the gearbox. The gearbox is placed between the frames, immediately back of the cylinder saddle, or may be located on the deck ahead of the saddle. The mechanism within runs in an oil bath. The oscillation of the two drive shafts is compounded by means of links and combining levers into four oscillating motions, two for the admission and two for the exhaust valves. Separation of the control for admission and exhaust motion is secured by varying the mutual relation between link blocks corresponding to the proper valves. The valve events are thus subject to control in practically unlimited steps through a single motion varying cutoff and reversing. The steam chests are located at either end of the cylinder, directly over the steam ports, with the cam box between the two steam chests. There are two admission and two exhaust valves for each end of each cylinder. The doubling of the valves permits generous port openings with small and light valves, and also a very moderate cylinder clearance.

The outstanding advantage of the poppet valve and gear is the possibility of operation with a much shorter cutoff than is possible with the radial valve gears. Assuming about 18 per cent to be the minimum cutoff for a Walschaerts gear, with 8 per cent clearance, the maximum expansion ratio for the steam would be about 3.5. It is actually considerably less than this since release occurs earlier than is desirable. The Franklin gear can be operated at 7.25 per cent cutoff, permitting an expansion ratio of nearly six, which is of the greatest importance in improving economy with steam of high pressure and superheat. Another important improvement to be obtained with the poppet valve is the reduction in the amount of locomotive power used to drive the valve gear. In the Franklin experimental installation, with a full-size gearbox and gears, the power requirement ranged from less than 1 up to 3.3 hp; the Walschaerts gear and piston valves are known to require as much as 50 hp at moderate speeds.

Fusion-Welded Locomotive Boiler. The test boiler in service on the Delaware and Hudson has made 105,000 miles[2] and has been given hydrostatic tests on two regular inspections without any sign of simmer or leak in the seams. Federal inspectors have required that this boiler have the covering removed and all seams and joints inspected quarterly during the first year of service, semi-annually in the second year, and annually thereafter. Every hydrostatic test is to be 50 per cent over the boiler working pressure. The boiler has been in service since September, 1937.

Welded Cylinders. Locomotive cylinders built up of rolled steel plates were noted in last year's Progress Report as having been built and found serviceable on French railways. The welded structural-steel cylinder is now an accomplished fact in America, recent advertising showing that one set is in satisfactory use on a heavy freight engine. The weight and cost of this pair of cylinders compare similarly to those of much smaller size reported from France last year, i.e., 25 per cent saving on each. Several other sets of cylinders are now under construction.

Locomotive Development Committee Report.[2] The Committee on Further Development of the Reciprocating Steam Locomotive reported the A.A.R. passenger-engine tests as a part of its pro-

[2] Report presented at Annual Meeting of Association of American Railroads, Mechanical Division, June, 1939.

gram, and its subcommittees made recommendations for tests both of a locomotive fitted with improved cylinders, poppet valves, and valve gear, and also the testing of various forms of counterbalance, particularly with relation to the most desirable amount and arrangement of reciprocating balance. The design subcommittee will shortly distribute preliminary drawings for a locomotive of the 6–4–4–6 type, capable of meeting the conditions of hauling 1000 tons of trailing load at 100 mph and designed in accordance with the specifications abstracted in last year's Progress Report.

Stoker and Reverse-Gear Orders. The present effective date of the order requiring the installation of stokers on modern locomotives to be completed is April 15, 1944, while the original provision of 20 per cent of installations each year beginning April 15, 1939, is still effective. The similar order regarding power reverse gears has for its final date Sept. 1, 1942.

Obsolescence. The shadow of the locomotive-obsolescence problem becomes yearly longer. At the beginning of 1939, a total of 1912 locomotives had been installed in the previous 9 years and 11,184 in the preceding 10 years (1920–1929). Therefore, 30,644 of the 43,800 locomotives now in service are more than 20 years old. A comparison with construction figures of 1910–1919 shows that 7000 or 8000 at least of this 30,000 were built before 1910. Of course, a considerable number of these ancients are "stored serviceable," at least in theory. Some have been modernized into better engines than they were originally, but it is a familiar fact that many of them are still in active service, especially switching. In this connection, Mr. Fry's summary of M. Chapelon's work[3] on locomotive practice might well be "required reading" for all American motive-power men. Chapelon traces the improvement of the locomotive from Sequin's machine of 1828, which produced 25 hp from 4.5 tons weight, to the P-O-Midi Pacifics of 1934 weighing 103 tons and producing 3700 hp (from 5.4 hp per ton to 36 hp per ton.) The main part of the story is concerned with the increase from 22 to 36 hp per ton obtained between 1929 and 1934, as a result of a scientific study of the rejuvenation possibilities of the P.O. 4-cylinder compound Pacifics. The superheat was increased, an improved exhaust nozzle applied, the area of the low-pressure steam passages was doubled, and the ihp increased

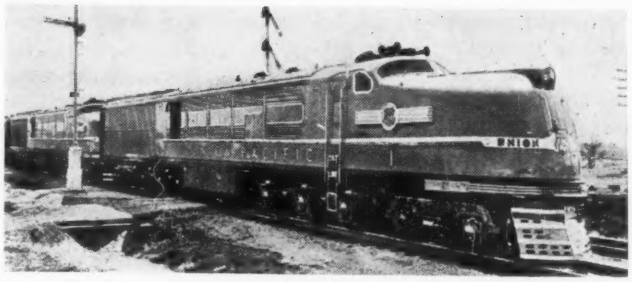

FIG. 19 TURBOELECTRIC LOCOMOTIVE FOR UNION PACIFIC

from 2200 to 3700, with less than 11 tons increase in weight. Starting 10 years ago with efficiencies corresponding to the best obtained in American practice, the application of scientific study to the thermal and mechanical processes which take place in the locomotive, the French engineers have produced locomotive designs which, on the basis of existing test data, will produce 6000 ihp from a locomotive weighing 350,000 to 360,000 lb, or 34 hp per ton. The compiler can find no American figure of better than 4700 ihp for a locomotive of this same weight.

In closing this section, the welcome appearance of the 1939 *Locomotive Cyclopedia* should be noted as the important publication of the year. It is similar in scope and make-up to previous editions, but includes as a new feature a useful bibliography on shop processes and equipment. If there is any complaint, it is that we have all become accustomed over many years to a locomotive book with blue-edged pages—and a car book with red! Why change?

THE STEAM-TURBINE LOCOMOTIVE

The steam-electric locomotive, designed by the Union Pacific and General Electric Company, was placed in operation early in 1939. This locomotive consists of two units each rated 2500 hp for traction in addition to provision of train-service power and heating steam. The units are identical and may be operated singly or in multiple unit from one master controller. Each unit contains a closed-cycle steam power plant consisting essentially of an oil-fired forced-circulation boiler, producing steam at 1500 lb per sq in. and 920 F, a geared turbine which drives the main generator, and an air-cooled condenser. Auxiliary turbines drive the condenser fans and the boiler auxiliary

[3] "The Evolution of the Steam Locomotive," by André Chapelon, J.-B. Balliere et Fils, Paris, France, 1938. An abstract of this book and comments upon it by Lawford H. Fry, are published in *Railway Mechanical Engineer*, Dec., 1938, pp. 473–475; Jan., 1939, pp. 1–5.

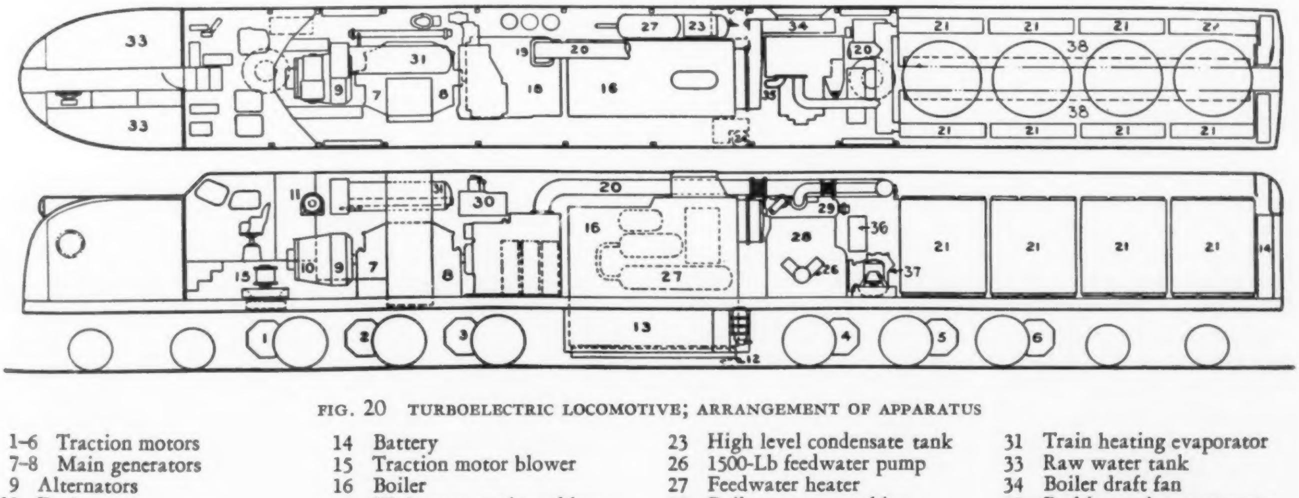

FIG. 20 TURBOELECTRIC LOCOMOTIVE; ARRANGEMENT OF APPARATUS

1–6 Traction motors
7–8 Main generators
9 Alternators
10 Exciter
11 Battery charging set
12 Braking resistor
13 Main control contactors
14 Battery
15 Traction motor blower
16 Boiler
18 High press. main turbine
19 Low press. main turbine
20 Exhaust header
21 Air-cooled condensers
23 High level condensate tank
26 1500-Lb feedwater pump
27 Feedwater heater
28 Boiler aux. set turbine
29 Condenser fan turbine
30 Compressor
31 Train heating evaporator
33 Raw water tank
34 Boiler draft fan
35 Braking resistor separator
36 Boiler control panel
37 Traction motor blowers
38 Fuel oil tanks

set, which consists of the high-pressure feed pump, combustion-air fan and fuel-oil pump.

The boiler control is completely automatic, with burners suitable for Bunker C fuel oil so that fuel cost is reduced to a minimum. The closed steam cycle permits the use of distilled water, which avoids the necessity of carrying large quantities of raw water and also allows the use of high-pressure, high-temperature steam with consequent economy.

The turbine-electric drive eliminates reciprocating power equipment with resultant reduction in maintenance, and avoids excessive axle loads and dynamic augment. The main generators supply geared axle-hung traction motors, six on each unit. The mechanical construction follows the general lines of high-speed electric locomotives with a 2-C-C-2 wheel arrangement. Because of the length, the driving trucks are not articulated and the space between them is used for equipment, including the lower part of the boiler. The trucks are fitted with specially designed stabilizers to permit operation at high speeds. The body is constructed of welded high-tensile steel and most of the sheets are aluminum to reduce weight. An outstanding feature is the use of the traction motors for electric braking. The braking energy is put into a water-cooled resistor and the heat is dissipated in the main condensers.

This locomotive was designed for use on the *Challenger* and streamliner trains between Omaha and Los Angeles and has proved itself capable of making up time with loads in excess of the 1000 tons for which it was designed.

L. P. Michaels has presented data[4] for conventional steam locomotives and Diesel-electrics, as compared with turboelectric, showing the following ratios:

	Conventional steam locomotive and tender	Diesel-electric locomotive	Turbo-electric locomotive
Weight of locomotive ÷ weight of trailing load	24–40%	27–36%	33%
Weight of locomotive ÷ hp of locomotive	170–220	160–180	210
Weight of trailing load ÷ hp of locomotive	430–796	367–554	644

INTERNAL-COMBUSTION LOCOMOTIVES

Several new Diesel-electric units of 2000-hp capacity each have been constructed by the Electro-Motive Corporation during the year. They are used in single units on the Rock Island Denver *Rockets*, the Kansas City Southern, and the *Silver Meteor* of the Seaboard; two units to the locomotive on the Chicago and North Western *400*, new power for the Santa Fe and Union Pacific, and three units to the locomotive on the Seaboard's *Orange Blossom*. Characteristic dimensions are a length of 70 ft per unit over couplers, a weight of 310,000 lb for end units and 290,000 lb for inside units, the use of two 1000-hp G.M. engines (two-cycle, 12-cylinder, V-type) direct-connected to 600-v, d-c generators, and six-wheel trucks, the outer axles being driven by traction motors, the interior axles for weight-carrying purposes only. (This gives an extremely complicated classification symbol—O-A1A-A1A-O for each unit.) The triple-unit *Orange Blossom* locomotives have the largest rated power of any Diesel-electric locomotive placed in service; they are composed of two A and one B unit, thus driving from either end. Auxiliary power provided on the triple-unit locomotive is 1800 hp, so they could properly be called 7800-hp machines. They are designed to handle 13 standard Pullmans. It is not quite "progress in mechanical engineering," but it is certainly progress in practical psychology that such a picture as Fig. 21 really gives no idea of the appearance of the new-type motive power—it requires a rainbow of colored paints and stainless-steel glitter to really get the effect. A gray or black Diesel-electric passenger engine would have no more "oomph" than a rusty gondola, and far less, certainly, than a set of flying rods and turning wheels on a steam locomotive. It seems to take this same "oomph" to sell passenger service—at least it ranks with high speed and air conditioning in the public mind.

Diesel-electric locomotives of smaller capacity include the power car for the *Pershing Zephyr* of the Burlington, with 1000-hp power plant having a six-wheel power truck with two traction motors under the front end, weighing 201,800 lb; a 1000-hp spare for the older *Rockets* of the Rock Island, and a number of 750-hp power cars to haul one coach for the Southern and Alabama Great Southern railways.

Orders for Diesel-electric switching and transfer locomotives continue. The usual characteristics of the power being ordered are as follows:

Nominal horsepower	600	900
Weight, lb	200000	250000
Engine arrangement	8-in-line	V-12
Starting tractive force at 30 per cent adhesions, lb.	66000	8300
Tractive force at 5 mph	...	...

The installation late last year of new Diesel-electric switchers for the Central of New Jersey marked some sort of anniversary, since it was this railway that placed the first unit of this type in service in 1926. The original locomotive, including the original engine is still in regular service. The comparison of principal characteristics will be instructive:

	No. 1000 (1936)	No. 1020 (1938)
Builder	A. L. Co.	A. L. Co.
Engine builder	Ingersoll-Rand	A. L. Co.
Engines: number	1	1
rated hp at speed rpm	300 at 600	600 at 700
cylinders, number, and size, in	6–10 × 12	6–12$^1/_2$ × 13
Traction motors	4	4
Motor ventilation	None	Blown
Maximum speed, mph	30	40
Tractive force, starting, lb	37300	65700
at 4.5 mph, lb	16800	36000

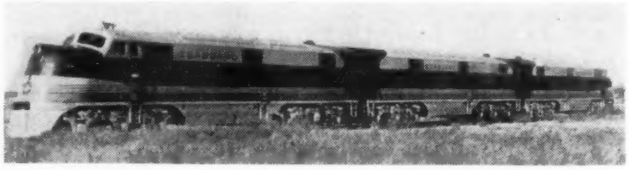

FIG. 21 DIESEL-ELECTRIC LOCOMOTIVE OF 6000 HP FOR SEABOARD AIR LINE

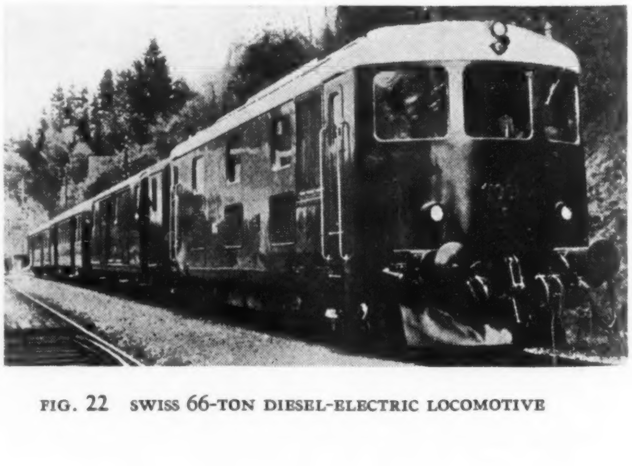

FIG. 22 SWISS 66-TON DIESEL-ELECTRIC LOCOMOTIVE

[4] "Steam-Turbine and Condensing Locomotives," by L. P. Michaels. Report presented at Annual Meeting of Railway Fuel and Travelling Engineers' Association, September, 1939.

A small rail car, properly classified as a locomotive, except that an alternative type of body with a few passenger seats is supplied, is being marketed by Coordinated Transportation, Inc., of Minneapolis. The engine is a 6-cylinder gasoline type developing 177 hp at 2100 rpm, driving the power truck on which it is mounted through a Lipe single-plate clutch and a Fuller 5-speed mechanical transmission. The car is designed to pull a trailing load of 250 tons, and its body may be arranged to carry either express or passengers or a combination. Standard couplers are fitted to each end, but with rubber block springs in place of the usual draft arrangements. The car is designed to run in either direction and, when running with the radiator at the rear end, a special arrangement of air scoops is placed in action to provide the needed cooling effect.

The Locomotive Construction Committee, A.A.R., Mechanical Division, made the following statements in its annual report[2] with regard to Diesel-electric locomotives: 110 were placed in service on 30 railways during the reporting period (June 1, 1938, to June 1, 1939); 20 of these were for road service and the remainder were switchers, or for transfer purposes. Typical service records of switching engines of 600 hp up to December 1, 1937, show the following ranges: Hours operated per year, 6050 to 7370; repairs, per hr operated, 25.8 cents to $1.58; fuel per hr, gal, 3.48 to 8.37; lubricating oil, gal, 0.077 to 0.3179. The high repair costs were incurred in the operation of units 9 years old, and in general a fair correlation between age and operating costs can be traced. H. H. Urbach of the C.B.&Q. made a notable contribution to general knowledge of Diesel-electric operation in his paper on this subject pointing out the various parts representing maintenance problems and methods by which dependability of operation could be secured.

Relatively few Diesel-electric locomotives were built abroad. The French railways acquired a second experimental 4400-hp locomotive, very similar to that previously reported, the engines being of the Sulzer type. The Swiss Federal Railways placed in service a light locomotive with Brown-Boveri engine and electrical equipment and Büchi supercharger developing 1200 hp at 750 rpm. The locomotive weighs 65 metric tons and has a maximum speed of 68 mph, Fig. 22. It is almost impossible to differentiate between a locomotive and the first car of an automotive train in European practice; reference to some passenger units which might properly be classified as locomotives follows in a later section.[5]

ELECTRIC LOCOMOTIVES

During the reporting year, the only construction of electric locomotives in this country consists of further additions to the Pennsylvania fleet of 4-6-6-4's (class G-G-1) noted in last year's Progress Report. There have been two types of electric locomotives built abroad notable for their high motor capacity in relation to total weight. Their principal details are:

	Reichsbahn	Swiss Federal Railways
Builder	A.E.G.	Oerlikon
Wheel arrangement	1D1	1B1B1 + 1B1B1
Line voltage	15000 s.p.	15000 s.p.
Weight of locomotive, lb	.....	550000
Adhesive weight, lb	180000	360000
Number of traction motor sets	4	8
Horsepower ratings:		
One hour	.....	12000
Continuous	5000	.....
Maximum	8000	.....
Tractive force:		
One hour	....	88000 lb at 46 mph
Maximum	60000	110000
Maximum speed, mph	111	68
Train handled, short tons	390 tons on 2.5 per cent grade, same on level at 110 mph	660 tons at 40 mph 840 tons at 31 mph both on 2.5 per cent grade

The Swiss locomotives are driven by motor sets in pairs, frame-mounted, driving through double-reduction gearing and a linkage.

AUTOMOTIVE RAIL CARS AND TRAINS

This classification is reserved for the rapidly increasing number of full-train units on the European continent and elsewhere, where the power units cannot be definitely classified as loco-

[5] Where all traction is supplied by the wheels of the leading vehicle of a train, if the power unit provides only room for baggage, etc., in spare space, it is generally considered to be a locomotive. If passenger accommodations are provided in the power unit, it is considered a rail car. Some foreign units provide interchangeable arrangements.

TABLE 3 AUTOMOTIVE TRAINS

Item No.	Railway	No. Cars	Length	Weight of Train Lb.	No. Revenue Seats	Engine Type and Hp.	Transmission	Notes
1.	Reichsbahn	3	229'8"	280,000	100	Maybach 1200 Hp.	Hydraulic	"Flying Silverfish"
2.	Reichsbahn	1	28'7"	18,000	37	Magirus 65 Hp.	Mylius Gearbox	
3.	Italian State Ry.	1	30'4"	34,000	35	Brescia-Saurer 130 Hp.	Mechanical	
4.	South Australia	1	58'5"		34	Gardiner 204 Hp.	Mechanical	Deluxe equipment, Hauls trailers
5.	Nizams Ry., Hyderbad	1	66'0"		84	2 Gardiner 204 Hp.*		Air conditioned
6.	State Rys., Greece	2	90'8"	110,000	67	M.A.N. 210 Hp.	T.A.G. Gearbox	
7.	Egyptian State Rys.	1	65'6"		Temporary only	Ganz 235 Hp.	Ganz 5-Speed Gearbox	For Freight Service
8.	Northwestern India	1	68'0"	65,000	100	Ganz-Jendrassik 250 Hp.	Mechanical	
9.	Belfast Suburban	1	60'0"	55,000	80	2 Leyland 260 Hp.*	Lysholm-Smith Torque Converter (Hydraulic)	
10.	Norwegian State Rys.	1	66'6	118,000	80	2 M.A.N. 300 Hp.*	Voith Turbo-Hydraulic	
11.	Madagascar Rys.	2		82,000	54	2 Saurer 360 Hp.*	Electrical (4 Motors)	
12.	Czechoslovak Rys.	1	69'6"	100,000	64	2 Kolben-Danek 460 Hp. *	Fluid Coupling, Prega-Wilson Gearbox	Hauls trailers
13.	French State Ry.	1	84'0"		73	2 Altham-Ganz 500 Hp. *	Electrical (2 Motors)	Hauls trailers, also takes power from 1500 V trolley
14.	Algerian Rys.	3		145,000	114	2 Sulzer 600 Hp.*	Electrical	
15.	Sao Paulo, Brazil	4	194'0"	245,000	134	Armstrong-Sulzer 600 Hp. *	Electrical	

* Total Hp. given

motives. The number of such units has become so great that it gives reason to wonder what uses railway managements will make of the smaller and obsolescent locomotives; they are being superseded for branch-line service and light passenger service in general. Some recent examples of this type of construction are listed in Table 3. Practically all are designed for moderate-speed service and consequently the mechanical or hydraulic transmission serves well, saving both in weight and cost over electrical equipment. Another feature of the relatively small engines installed is the improvement in the weight-horsepower ratio; 20 lb per hp is now a characteristic figure. Moderate speed is not a necessary feature of these installations, however. One of them, the Reichsbahn *Flying Silver Fish* in June established a new speed record for practicable railway equipment of 215 km per hour, or 133.6 mph. This is the nearest approach yet obtained to the 143 mph record of the Kruckenberg propeller-driven car.

Two electric trains of considerable current interest may be noted under this heading. The three-car train of the Italian State Railways exhibited at the New York World's Fair is fully articulated. The end trucks are fitted with two traction motors each and the articulating trucks have one each, the total output of the six motors being 1500 hp. The line voltage is 3000 dc. The motors are frame-mounted, driving the axles through a quill arrangement. The cars are streamlined to the extent of having friction-reducing end forms, smooth exteriors, and skirts between trucks extending to within 10 in. of the rail. The motors and gearing are designed for top speeds of 125 mph, and one of these trains has actually made the 130-mile Rome-Naples run in 90 minutes. The first car provides space for baggage, mail, crew quarters, and a kitchen; the second and third cars have 46 and 54 seats, respectively.

The unusual mechanical features of an experimental train for the Brooklyn Rapid Transit call for brief notice in this report. This train consists of three car-body units on four trucks, the latter similar to the now familiar P.C. trucks in use on street railroads. These are rubber-sprung to reduce noise and improve riding qualities, and have rubber-insert wheels. The train is 80 ft 4 in. long, weighs 76,000 lb, has 84 seats, is provided with eight G.C. traction motors totaling 720 hp, providing acceleration as high as 4 mphps and 40 mph running speed. The car bodies were built by the Park Equipment Company and liberal use of aluminum alloys was made. The braking system is entirely automatic; electrodynamic braking is used down to 4 mph when air braking is automatically initiated, and in the final stage of the stop the electric track brake is used. Mirrors, improved lighting, forced ventilation, and filtered air should give the traditionally harried rider something of a "break."

PASSENGER CARS

Attention to passenger-car construction continues to be focused on the lightweight car for high-speed service, either as a more-or-less fixed unit of a "streamliner" or as an independent vehicle. As to interior arrangement, there is a rapid increase in the number of de luxe coaches, designed for maximum comfort in long-distance travel.

Coaches for Diesel-electric trains ordered during the reporting year include the following: Three seven-car stainless-steel trains for the Seaboard; two similar trains for the Atlantic Coast Line; two sleepers each for the *City of Denver* (U.P.C. & N.W.) and the *Denver Zephyr* (Burlington), the former of Pullman and the latter of Budd construction; two 8-car *Rockets*, including sleepers, for Denver service (C.R.I.&P.), the sleepers built by Pullman and other cars by Budd; 20 cars from Pullman for the new equipment of the North Western's *400;* three *Zephyr*-type cars for the new *Pershing* train from Budd (Burlington); and six coaches, each to run with a power car for the Southern and Alabama Great Southern, built by the St. Louis Car Company.

New lightweight coaches for regular steam-train service ordered during the year include forty Pullman sleepers of the room type each, for the Pennsylvania and New York Central lines; 27 cars for Pennsylvania's *Blue Ribbon Fleet* from Budd, Pullman, and the American Car & Foundry Co.; two 14-car *Daylight* trains for the Southern Pacific from the Pullman Company; and eleven Budd and Pullman cars for the Santa Fe.

Late in 1938, the Chicago, Milwaukee, St. Paul and Pacific placed in service new equipment for its *Hiawatha* trains, all of which were built in the railway's Milwaukee shops. Forty-one units for service on the main-line trains were built, and twenty additional cars for replacement of branch-line equipment. The use of a new type of truck, incorporating roller bearings, coil-spring suspension exclusively, hydraulic shock absorbers, and a side-sway stabilizer all within a weight of 15,000 lb, which includes the generator, is one of the most notable features of a series of notable designs. The cars are constructed of Corten steel throughout, except for the wall paneling, which is of walnut and bleached maple. Each car is about 82 ft long over buffers. The coaches and parlor car have one vestibule each, the taproom and diner having none. The saving in weight over normal riveted carbon-steel construction is about 40 per cent. The train consist is as follows:

	Seats	Weight, lb
Express taproom	44	98800
Coaches (four in train)	70	93400
Diner	52 and 16 (in cafe)	105400
Drawing-room parlor (two)	39	93300
Beaver-tail parlor	45	91700

There is a total of 300 revenue seats and 199 nonrevenue seats. The total train weight is 428 tons. In Figs. 23, 24, and 25, car constructions and decoration are shown; Fig. 26 shows the truck, indicating the arrangement of the Monroe shock absorbers, the coil-spring suspension, and the levelizing bar or bars to keep the bolster level.

The Pullman train at the New York World's Fair is especially interesting for the luxuriously equipped room-observation car, the *Car of Tomorrow*. The accommodations include the observation lounge, a completely equipped buffet, a drawing room, a compartment, and two double bedrooms with a fold-wall between, permitting their use either as one large room or as individual units. The car is of lightweight-alloy construction with front-vestibule and solarium-type rear end, with a moderately deep side apron between the trucks, Figs. 27 and 28.

The *Coronation Scot* train came to this country in the spring as a messenger of good will and as part of the British exhibit at the New York World's Fair. The principal dimensions of the locomotive (bearing the name *Coronation*) are shown in Table 2, item 1. Fig. 10, reproduced from last year's report, shows the general appearance and streamlining of an identical engine.

The *Scot* train has five vehicles of eight body units as:

		Length, ft-in.	Weight
Corridor first class, brake van	16 seats		
articulated with		123–8	132600
Corridor first class	24 seats		
Corridor first class, lounge	28 seats		
articulated with		123–8	136500
First-class diner	44 seats		
Kitchen unit			
articulated with		123–8	149900
Third-class diner	44 seats		
First-class sleeper	12 berths	72–8	98600
Club saloon, brake van	17 seats	63–1	70400

FIG. 23 MILWAUKEE *Hiawatha* COACH

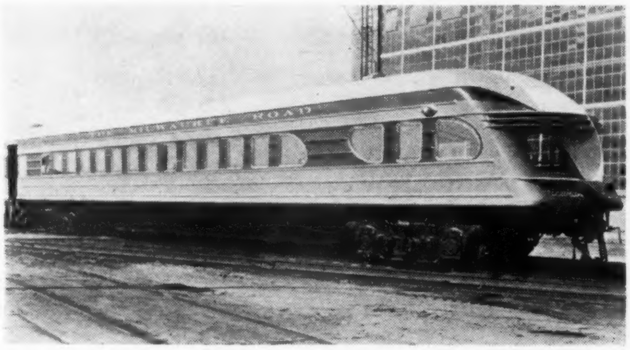

FIG. 24 MILWAUKEE *Hiawatha* OBSERVATION CAR

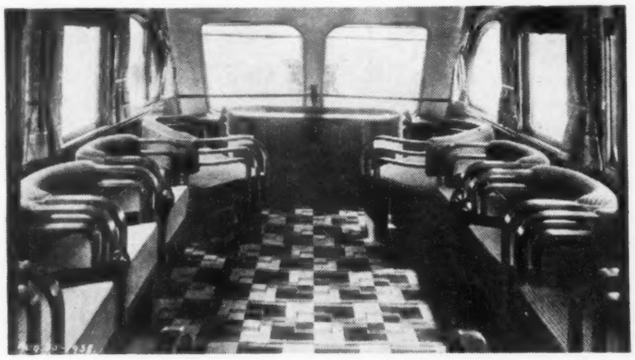

FIG. 25 INTERIOR OF BEAVER TAIL COMPARTMENT OF *Hiawatha* OBSERVATION CAR

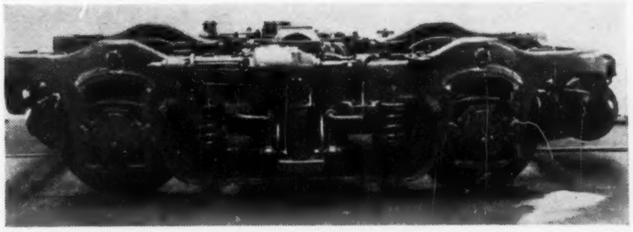

FIG. 26 TRUCK FOR *Hiawatha* CARS

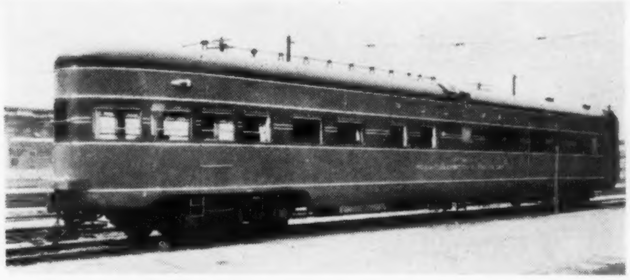

FIG. 27 ROOM-OBSERVATION PULLMAN; NEW YORK WORLD'S FAIR EXHIBIT

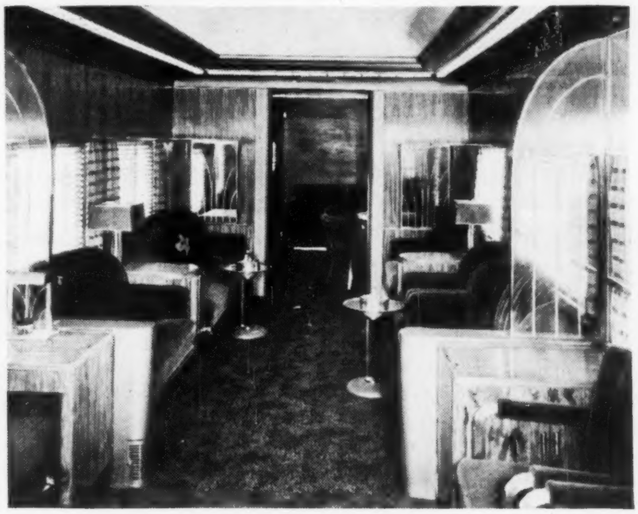

FIG. 28 INTERIOR OF OBSERVATION COMPARTMENT, ROOM-OBSERVATION PULLMAN

The cars are streamlined to the extent of having external projections reduced to a minimum, the provision of rubber curtains between the car bodies, and deep aprons extending downward from the side sills toward the rails between the trucks. The external finish is in deep red with gold banding, the finish being carried through to the "prow of the locomotive." The side sills and side plates of the car bodies are of high-tensile steel, welded together to form a single unit, with welded sockets to receive teak body posts. All of the frame members are of mild steel, welded throughout. Body framing is of timber, to which the 16-gage side panels are screwed. Cork, leather, and asbestos linings have been extensively used as insulation for sound. The heating-and-ventilating equipment consists of steam coils, fans, and filters in series, but no cooling equipment is provided. There has been general comment on the appearance of spaciousness in these cars, a result undoubtedly secured by uncrowded seating and by large window openings, despite a reduction of 15 in. below the customary American car width. Figs. 29, 30, and 31 show some of the features of this train.

The railways of Canada played a major part in making the visit of King George VI and Queen Elizabeth in June an unmarred success. The feat was mainly one of operation rather than engineering, but the specially prepared *Royal Train* deserves notice in this survey. For this train, the two Canadian lines each prepared six cars, including the two private cars of the Governor-General, other private cars, diners, and a baggage car. These were uniformly decorated in blue and silver, with the royal arms and cipher prominently displayed. The objection of the Canadian Premier to an air-conditioned car was respected—perhaps he was sorry on the trip to Washington! The six Canadian National cars of the train are shown in Fig. 32.

In reconditioning the *Copper King* observation car for the *City of Los Angeles*, the Union Pacific installed an innovation in the form of a substitute for window glass; two layers of a

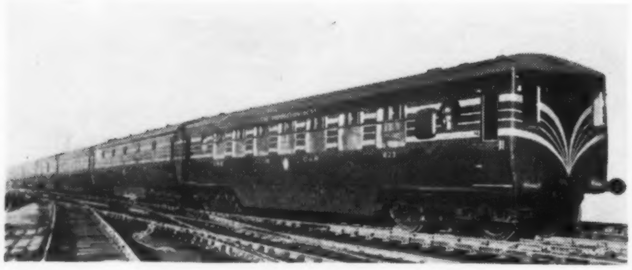

FIG. 29 EXTERIOR OF *Coronation Scot* TRAIN

FIG. 30 FIRST-CLASS COMPARTMENT *Coronation Scot* TRAIN

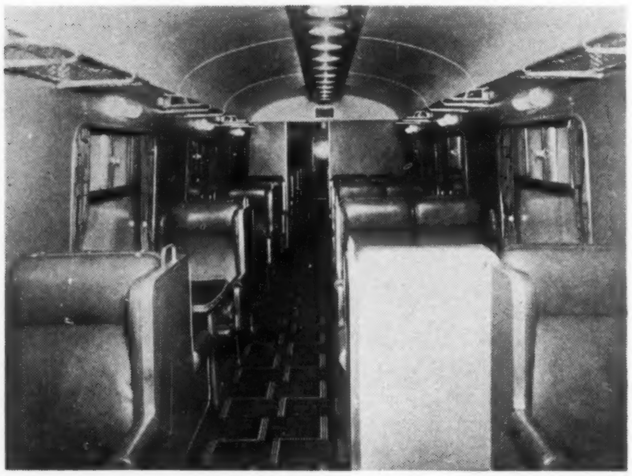

FIG. 31 THIRD-CLASS DINER, *Coronation Scot* TRAIN

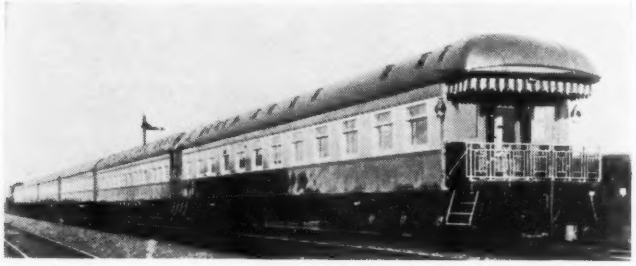

FIG. 32 CANADIAN NATIONAL RAILWAYS' CARS IN THE *Royal Train*

plastic known as Polaroid is placed in the round window casings and by a gearing arrangement the two may be relatively rotated. In one position, light passes normally through the two layers as through a window; as one sheet of Polaroid is rotated through 90 deg, the amount of light admitted by the polarizing process is decreased until, at the right-angle position, the window is wholly dark. Another lighting innovation that has been used in several recently built cars is the fluorescent lighting tube.

The third Progress Report[3] on the fatigue-testing of passenger car axles was issued in June, containing records of extensive tests difficult of summarization.

FREIGHT CARS

There are nineteen freight cars in the track exhibit at the New York World's Fair, from a D.&H. 40-ton hopper to a 188-ton Pennsylvania flat car with sixteen wheels in four 4-wheel trucks. They constitute a very satisfactory progress report in themselves. Several of these have previously been noted before the Railroad Division and only a few of them appear in the tabulation of current construction herewith. Table 4 (on page 875) lists a number of recently built cars. The Southern and D.&H. box cars are conventional in size and weight. The two 50-ton box cars (Items 3 and 5) are of all-welded steel construction, and show weight savings of about 8000 lb below the A.A.R. standard. The Southern furniture car is heavy because of its long body. The A.C.F. refrigerator car is built up of welded assemblies (frame, roof, sides, and ends), these being riveted together. The Morrell car has a standard A.A.R. underframe and body frame, no attempt being made to utilize the strength of the side construction. The lumber used in building this car, in place of the regular matched boards, is Douglas-fir plywood panels. These cars are part of an order of 100, of which 90 are of standard construction. The use of plywood reduced the number of pieces and fastenings in the superstructure by 88 per cent, and reduced the weight 3000 lb. The two flat cars, of the same nominal capacity, are of entirely different construction; the Pennsylvania car has a one-piece cast-steel underframe; the Milwaukee car is of all-welded low-carbon-steel construction.

The arch-bar truck is making its last stand. Originally prohibited in interchange after January 1, 1936, the date has been gradually extended to December 31, 1939. As of April, 1939, less than 10 per cent of the cars in service were not fitted with newer types of trucks. The same expiration dates will see the end of the 5×5-in. shank coupler; the 5×7-in. shank has two more years of grace. Mr. Patterson (formerly Director of the I.C.C. Bureau of Safety, now Commissioner) has sharply called attention to lagging progress in fitting the new standard AB brake. As of April, 1939, 40 per cent of the cars in service should have been fitted with these brakes, while actually only $12^1/_2$ per cent had been so equipped.

In accordance with arrangements of the A.A.R. Mechanical Division, a series of service tests is in progress with freight-car trucks designed for high-speed service. Twelve designs of such trucks are now undergoing tests on the Pennsylvania Railroad.

The Car Construction Committee in June reported that research into the economics of lightweight cars was proceeding. This study is based on the use of the standard-design box car, as compared with other car bodies of the same size, but having from 6 to 24 per cent less weight and hence greater load limit.

GENERAL NOTES AND STATISTICS

In the following tables, facts regarding current orders, etc., will be found.

TABLE 5 EQUIPMENT ORDERED, SEPTEMBER, 1938–AUGUST, 1939

Month	Locomotives— Steam	Diesel-electric	Passenger cars	Freight cars
1938				
Sept.	5	14	12	1179
Oct.	..	29	20	...
Nov.	1	4	32	1120
Dec.	10	16	80	2574
1939				
Jan.	..	5	47	3
Feb.	53	1	..	2204
March	..	6	60	3200
April	..	15	2	2460
May	..	53	18	1075
June	3	7	14	1326
July	..	2	14	...
Aug.	..	3	..	315

Table 5 includes only domestic orders, and does not include railway-shop-built equipment.

The following table gives the number of units of equipment on order and installed for the first seven months of 1939 as compared with the same period for 1938.

	Equipment —installed—		Equipment —on order—	
	1938	1939	1938	1939
Steam locomotives	136	20	60	72
Electric and Diesel-electric locomotives	82	119	23	48
Freight cars	6927	10302	10234	8473

TABLE 4 AMERICAN FREIGHT CARS

Road	Type	Builder	Journals	Weight — Light	Weight — Load Limit	Body Dimensions L x H x W	Length over Striking Casting	Cubic Cap.
Southern	40 ton Box	Pul. Std.	5x9	44,700	91,300	40-6x10-0x9-2		3713
D. & H.	40 ton Box	D. & H.	5x9	42,700	93,300	40-6x9-4 x8-9	41-8½	3318
A.C.F.	50 ton Box	A.C.F.	5½ x10	37,500	131,500	40-6x10-0x9-2	41-8½	3723
Southern	50 ton Furn.	Mt. Vernon	5½x10	53,300	115,700	50-6 x10-0 x9-2		4628
G.A.T.Co.	50 ton Box	G.A.T. Co.	5½x10	36,800	132,200	40-6x10-0x9-2	41-8½	
A.C.F.	Refrig.	A.C.F.	5x9	44,200		33-3 x7-9 x8-3		1988*
Morrell	Refrig.	G.A.T. Co.	5x9	60,600	75,400	33-1 x7-5 x9-5	41-8½	1899*
D. & H.	40 ton Hopper	Ry.	5x9	32,700	103,300	28-0 x 10-5	28-11½	1752
Burlington	50 ton Hart Conv.	A.C.F.	5½ x10	46,300	122,700	33-4		1970
C. & N.W.	70 ton Hopper	P.S.C. Co.	6x11	51,700	158,300	39-0x9-6	40-4	2590
L. & N.E.	70 ton Hopper (Cement)	A.C.F.	6x11	53,800	156,200	29-3 x 9-5	35-1¾	1790
C.M.St.P.&O.	60 ton Flat	Ry.	5½x10	45,600	123,400	52-6 x10-6	53-3	
Penn.	70 ton Flat	Ry.	6x11	51,600	158,400	50-0 x10-2		

* Between Bulkheads

The number of air-conditioned cars reached 11,500 in the middle of the present year, with the work proceeding at the rate of 800 cars per year.

ACKNOWLEDGMENTS

The chairman of the committee and compiler of the present report acknowledges with appreciation the contributions and cooperation of the other members of Committee RR6 in the preparation of the material herein. The following railways and manufacturers have given material help: Baldwin Locomotive Works, American Locomotive Company, Lima Locomotive Works, Electro-Motive Corporation, Pullman Standard Car Manufacturing Company, Union Pacific Railroad, Pennsylvania Railroad.

The illustrations used are credited to the following sources: Figs. 1 and 2, Pennsylvania Railroad; Figs. 3 and 9, American Locomotive Company; Figs. 4 and 7, Baldwin Locomotive Works; Fig. 8, Union Pacific Railroad; Figs. 5, 6, and 18, Lima Locomotive Works; Figs. 10, 11, 12, 13, 17, and 22, The Railway Gazette; Figs. 14, 15, and 16, Report of A.A.T. Passenger Locomotive Tests; Figs. 19 and 20, General Electric Company; Fig. 21, Electro-Motive Corporation; Figs. 23, 24, 25, and 26, Chicago, Milwaukee, St. Paul and Pacific Railroad Co.; Figs. 27 and 28, Pullman-Standard Car Manufacturing Co.; Figs. 29, 30, 31, *Railway Age;* Fig. 32, Canadian National Railways.

Education for Industry

IN HIS presidential address before Section L of the British Association, delivered at Dundee on August 31, 1934, A. P. M. Fleming, well known to engineers in the United States for his discussions on industrial education, had something to say about recruitment of teaching staff for engineering colleges. The following is quoted from a report of Mr. Fleming's address that appeared in *Engineering* for Sept. 15, 1939.

An educational problem that is already acute and will be even more so in the future is the supply of suitable teaching staff for the universities and technical institutions. Formerly much of the scientific and technical development relating to industry came from the universities. Due largely to the establishment of large-scale research by industrial concerns, and to the great expansion of their technical staffs, the initiative in progress has passed to industry, and many scientists who previously found their vocations in academic life are now attracted to scientific and technical employment in industry. The result is that in those faculties in which the work has a technological bearing there is a great shortage of personnel available for teaching, so that the time is opportune for the technical institutions and universities to consider a long-term policy as regards selecting and training those who will eventually become the academic leaders. In this connection cooperation should be arranged with industry to provide a suitable range of practical experience without the permanent absorption of the personnel so trained. Industry has already shown its willingness to cooperate with education in this respect by providing short "refresher" courses for those in academic employment. The technical knowledge and experience of eminent technologists in industry might well be utilized more completely than at present by coopting such men to the professorial staffs of universities and technical colleges, and thus augmenting, for special courses, the existing teaching facilities. New technical processes now arise so rapidly from scientific discoveries and become promptly established in industry that the textbooks used for teaching purposes can never be completely up to date. The introduction of post-advanced courses in the Lancashire area appears to be the correct solution to this problem. These courses, which comprise short series of lectures on specific technical subjects, are given mostly by experts in industry and are conducted on a basis of exposition and discussion. They serve admirably the needs of the technologist in industry.

MECHANICAL PROBLEMS *in* BRITISH TRANSPORTATION

Abstracts of Four British Papers Dealing With Airplanes, Motor Vehicles, Railroad Cars, and Merchant-Marine Ships

[The British American Engineering Congress, embodying the joint Fall Meeting of The American Society of Mechanical Engineers and The Institution of Mechanical Engineers (Great Britain), which was scheduled to take place in New York City, Sept. 4–8, 1939, but was canceled at the last moment because of the European situation, included a technical program devoted to the "Mechanical Problems of Modern Transportation," a subject of great importance and one to which both countries have made worthy contributions. At each of the four technical sessions, there was to be one paper by a British and one by an American author. The British papers, which are abstracted in this issue, have been issued in preprint form prior to publication in the Proceedings of the Institution.

Members of The American Society of Mechanical Engineers are invited to submit discussion in writing by January 1, 1940. A limited number of these preprints are available and may be obtained from Society headquarters.—Editor.]

Transatlantic Air Transport With Particular Reference to Flying Boats

By A. GOUGE

GENERAL MANAGER, SHORT BROS., LTD., ROCHESTER AND BEDFORD, ENGLAND

Flying boats, weighing about 40 tons, carrying 24 passengers and a crew of seven, and traveling at a height of 12,000 ft, will be the chief means of air service across the Atlantic Ocean in the near future. In the various routes available for air service across the Atlantic, the most desirable one is flying from Southampton to New York direct, as this would shorten the distance to be flown and eliminate unnecessary stops. From Southampton the direct route is possible all the year round, but New York may not be suitable during the winter months, when it would be necessary to use a temporary ice-free base probably near Delaware Bay. The distance to be flown on the winter route would be approximately 3640 miles as compared with the Southampton-New York distance of 3450 miles.

The transatlantic route is the most difficult on which to establish regular services, due to the variable weather conditions, the presence of regions below freezing temperature, and the necessity of covering a great distance nonstop. In the case of the transatlantic airplane it is of the utmost importance to obtain the highest efficiency possible as the weight of the fuel necessary for the crossing is a high percentage of the total weight carried. The airship accomplished the first regular transatlantic service, when in 1936 the *Hindenburg* made several successful crossings carrying passengers, before coming to an untimely end. Passengers who have crossed by airship all speak of it as the ideal method of travel, and, if the fire hazard is overcome, possibly by the use of helium, it is likely that further airship services will be organized in the future. The heavier-than-air type is, however, favored as the ultimate form of intercontinental communication because of the very much higher cruising speed that can be maintained. As between the airplane and the flying boat the question is more open, but it is probable, largely on account of take-off and landing problems, that future development will center around the flying boat. Just as there was a transitional period between the sailing vessel and the steamship, there will also be a transitional period from steamship to airplane, and the author is firmly convinced that the airplane will finally displace the steamship except for the transport of heavy cargo.

DESIGN OF TRANSATLANTIC AIRPLANES

Considering the problem of designing aircraft for the transatlantic crossing, the author envisions medium-size aircraft of about 80,000 lb total weight, either of the land or seaplane types. To give the maximum performance possible with aircraft of the land type, he contemplates a design in which the nacelle and undercarriage drag are entirely eliminated and the cooling drag reduced to 2.7 per cent. Providing the surface finish is good and due regard is paid to intersection of surfaces and the prevention of leaks, the drag of such an airplane should not be more than 1.64 times the actual skin-friction drag of the exposed surfaces. Beyond this it does not appear possible to go at the moment, although research is now being directed toward a study of boundary-layer flow and probably in the near future means will be found for controlling the boundary layer. This will make possible a still further increase in cruising speed for a given power, combined with an increase of maximum lift and a lower landing speed.

In the tentative design of the proposed airplane, the weight assumed is 10,000 lb for pay load plus crew, which would allow for 24 passengers and their baggage of 250 lb each, seven crew members with effects, and approximately 2700 lb of mail. The machine would be of the mid-wing monoplane type with four engines moderately supercharged to 10,000 ft. The take-off power would be 1600 bhp per engine, and the maximum economic cruising power 900 bhp per engine. The estimated weights would be as follows:

Power unit	11,820 lb	Equipment	4,140
Tankage	1,040	Fuel and oil	25,350
Structure weight	23,250	Pay load plus crew	10,000
Total weight			75,600 lb

This would give a wing loading on a wing area of 2050 sq ft of 36.9 lb per sq ft, and a power loading, at maximum economic cruising power, of 21.1 lb per hp. The mean cruising speed would be 266 mph and the range at maximum economic power after making an allowance for $^1/_4$ hr at full throttle for the take-off, 3485 miles against a 40-mph head wind. The take-off distance to clear a 66-ft obstacle against a $5^1/_2$-mph head wind would be 1150 yd.

It will be seen that the time taken on the trip against a 40-mph head wind is about 15.4 hr, which, allowing for the change in time of five hours between London and New York, would enable an airplane leaving London at 10:30 p.m., G.M.T., to arrive in New York at 9:00 a.m., E.S.T., the next morning. The trip in the reverse direction would not be quite so convenient as an allowance cannot be made for more than a 15-mph tail wind. This would necessitate a flight of 12.5 hr, which with a departure from New York at 3:30 p.m., E.S.T., would give an arrival in London at 9:00 a.m., G.M.T., the next morning.

TRANSATLANTIC FLYING BOAT

A flying boat corresponding with the proposed airplane already described, and having the same engines, would have the following estimated weights:

Power unit	12,100 lb
Tankage	1,390
Structure	22,610
Equipment	4,500
Fuel and oil	32,200
Pay load and crew	10,000
Total weight	82,800 lb

The wing loading on a wing area of 1675 sq ft would be 49.4 lb per sq ft, and the power loading at maximum economic cruising power, 23 lb per hp. The mean cruising speed from Southampton to New York would be 217 mph, and the range at maximum economic power, after allowing for $^1/_4$ hr at full throttle for the take-off, would be 3450 miles. The take-off distance would be 1600 yd.

In this case, with the allowance for a 40-mph head wind, the time taken would be approximately 19.5 hr for the westward flight. The return trip would take 15 hr. It will thus be seen that for this size of machine there is really no choice between the flying boat and the airplane when judged from the point of view of performance. The flying boat, however, affords a feeling of additional security and more commodious accommodations, and eases the take-off and landing problems.

FLYING BOAT OF THE FUTURE

Engines are now available that make it possible to design a flying boat, as shown in Figs. 1 and 2, with a total weight in the neighborhood of 170,000 lb. Such an aircraft would be of the high-wing monoplane type with six engines moderately supercharged to 10,000 ft. The take-off power would be 2100 bhp per engine, and the maximum economic cruising power, 1300 bhp. The weight of the craft would be made up as follows:

Power unit	23,320 lb
Tankage	2,670
Structure	54,110
Equipment	8,700
Fuel	62,350
Pay load plus crew	11,850
Total weight	163,000 lb

The wing loading on a wing area of 3380 sq ft would be 48.2 lb per sq ft, and the power loading at maximum economic cruising power, 20.9 lb per hp. The mean cruising speed would be 237 mph, and the range at maximum economic power after take-off would be 3450 miles. The take-off distance would be 1760 yd.

In all the foregoing proposals it has been assumed that the aircraft would cruise at an altitude of 10,000 ft. In any discussion of the future of a transatlantic service consideration must be given to the results of the research now being made into high-altitude flight. However, transport operators will need convincing proof that the advantages to be gained are worth the

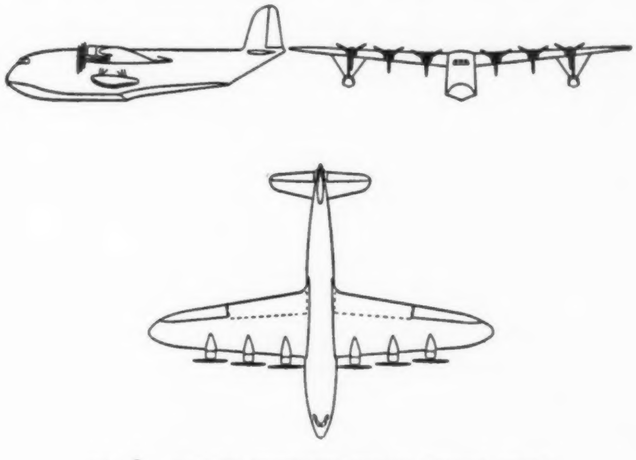

FIG. 1 FUTURE DEVELOPMENT IN FLYING BOATS

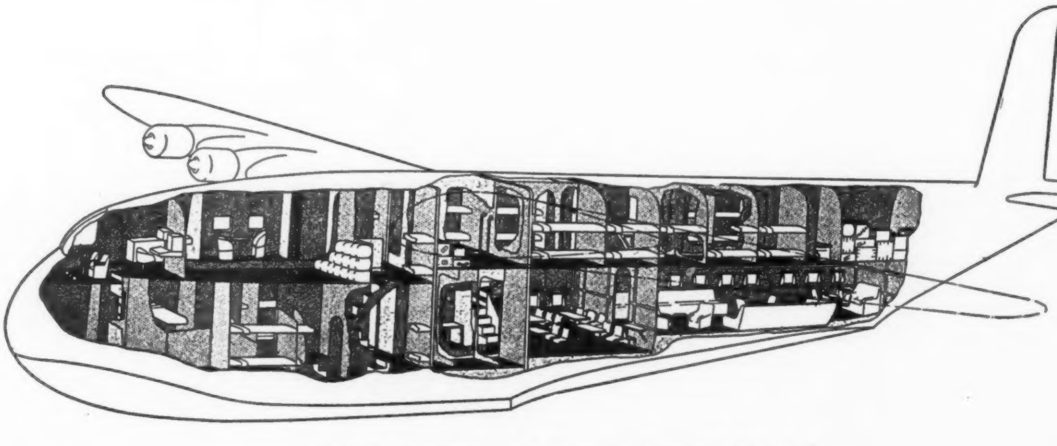

FIG. 2 INTERIOR OF FLYING BOAT SHOWN IN FIG. 1

complications both in the engines and the aircraft, including the maintenance of a pressure of 6–7 psi above atmosphere in the cabin. The advantages so far as present knowledge goes are an appreciable increase in cruising speed for the same expenditure of power, and the fact that flights could be made in regions of ideal weather conditions.

Motor Transport

By E. C. OTTAWAY

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THE modern era of motor transport in Great Britain may be regarded as having commenced in 1896, with the passing of the Locomotives on Highways Act, previous to which the speed of a self-propelled vehicle was limited to 4 mph, and it was required that its passage along the road should be preceded by a "man with the red flag." The position reached by the year 1900 is revealed in a paper[1] presented at that time by Dr. H. S. Hele-Shaw, who stated in his introduction: "There are strong reasons for thinking that the subject of mechanical propulsion upon common roads has now reached a point when it deserves the very careful consideration of mechanical engineers." Thus was mechanical transport born a foundling and adopted by the engineer.

The statistics relative to the growth of motor transport in Great Britain are of interest. Great Britain today possesses 179,000 miles of road distributed over an area of 88,750 square miles. Of this road mileage 15.1 per cent is classified as constituting the main national traffic arteries, and a further 9.5 per cent as secondary traffic arteries of less importance. The remainder of the road mileage is regarded as of local importance only. In 1908 there was but 0.8 vehicle per mile of road, whereas in 1937 there were 16.4, corresponding to 66.7 vehicles per mile of classified road.

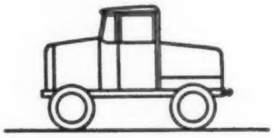
NATIONAL CONTROL OF MOTOR TRANSPORT

The advent of national control of motor transport was foreshadowed by the formation of the Ministry of Transport in 1919. Since then, various acts of Parliament have set up for buses and trucks licensing authorities known as Traffic Commissioners who are directly responsible to the Ministry of Transport. For the purpose of administering this licensing system under the acts, Great Britain is divided into 12 traffic areas each of which is presided over by three commissioners, except in the London area where a single commissioner is the licensing authority. Assisting the commissioners in the control of both the traffic and the vehicles are certifying officers, experts in automobile design and construction, who issue certificates of fitness which are only issued following thorough examination and upon proof of compliance with constructional requirements, some of which are illustrated in Fig. 3.

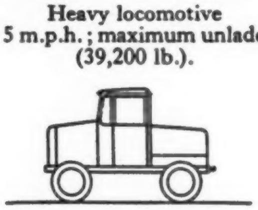
In addition to limiting dimensions and maximum weight the regulations descend to considerable detail in regard to such matters as braking and brake design, springing, steering, and position of fuel tanks. The regulations are, in the main, logical, and are based on an understanding of the road and traffic conditions under which the vehicles operate. There is some criticism both by manufacturers and operators mainly directed against the restrictive clauses dealing with weight and dimensions. There are two requirements not connected specifically with the construction of the vehicle but which have exerted a large influence on design. The first requires the employment of conductors and the second limits the number of standing passengers to 25 per cent of the seating capacity of any one deck and must not in any case exceed five in number on any vehicle. This restriction of overload capacity directly serves to increase the cost of travel, and in the author's view, is one of the main causes of traffic congestion in large cities.

CHASSIS AND BODY

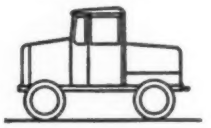
Chassisless construction, though generally used in America, has made little headway in Great Britain. Experimental vehicles have been produced and the subject is widely discussed. It is probable, however, that certain differences in the conditions prevailing in Great Britain will retard its progress. The manufacture of road-transport vehicles is, in the main, sharply divided between body and chassis. The primary advantage claimed is presumably a reduction in weight. In a typical double-deck bus, the chassis frame amounts to approximately 952 lb, to which may be added 560 lb, representing the weight of the structural parts of the body floor frame, giving a total of 1512 lb, or roundly 6.5 per cent of the total laden weight.



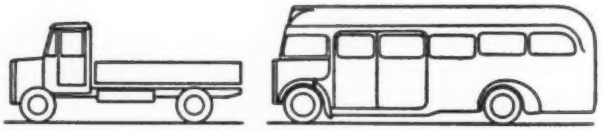
Heavy locomotive
Maximum speed, 5 m.p.h.; maximum unladen weight, 17½ tons (39,200 lb.).



Light locomotive
Maximum speed, 8 m.p.h.; maximum unladen weight, 11½ tons (25,760 lb.).



Motor tractor
Maximum speed with trailer, 8 m.p.h.; maximum unladen weight, 7¼ tons (16,240 lb.).



Heavy motor car
Maximum speed, 20 m.p.h.; maximum speed with trailer, 16 m.p.h. — **Maximum speed, 30 m.p.h.**
Unladen weight in excess of 2½ tons (5,600 lb.)

Motor car
Maximum speed, 30 m.p.h.; maximum unladen weight, 2½ tons (5,600 lb.). — **Maximum speed unlimited; maximum unladen weight, 3 tons (6,720 lb.).**

FIG. 3 CLASSIFICATION OF MOTOR VEHICLES IN GREAT BRITAIN

[1] Proceedings of The Institution of Mechanical Engineers, 1900, p. 185.

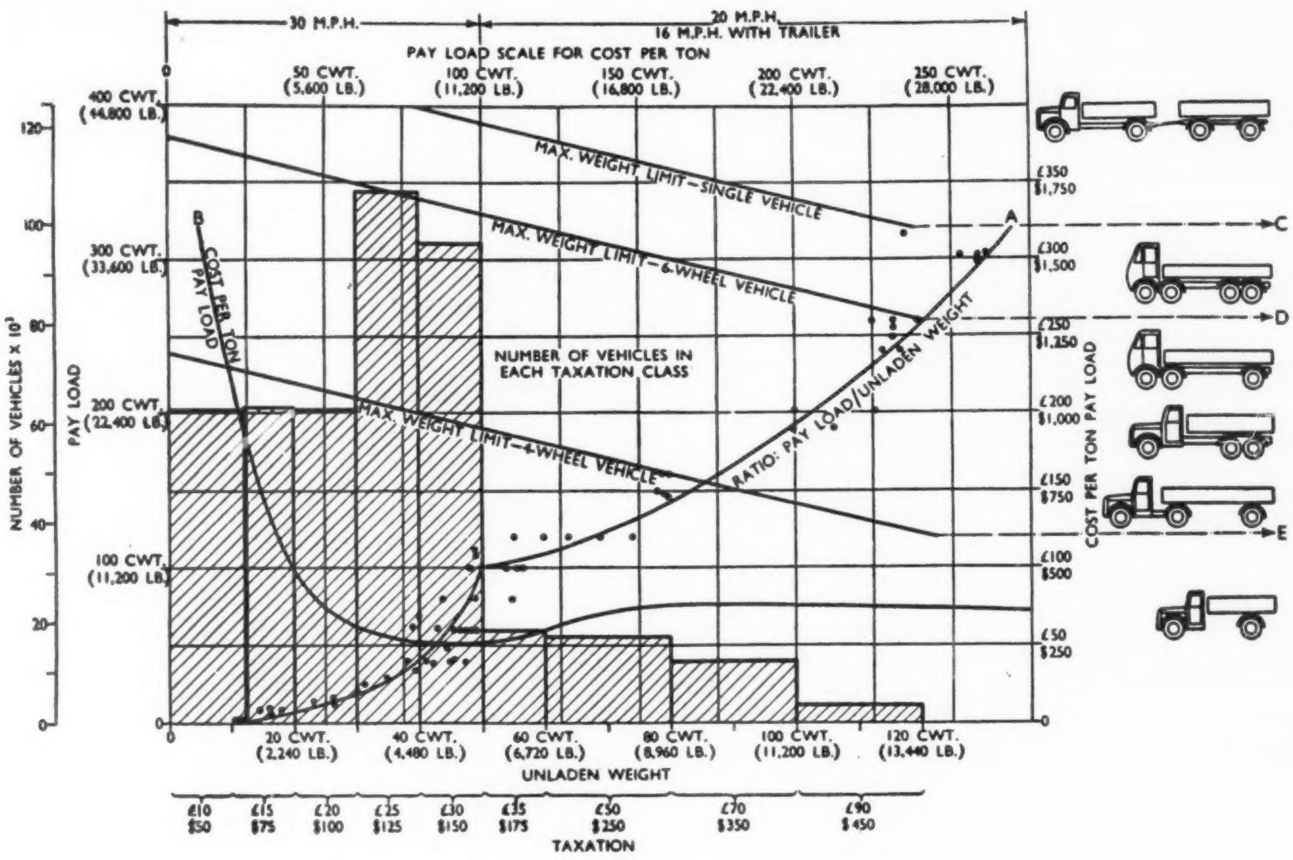


FIG. 4 CHARACTERISTICS OF FREIGHT-CARRYING TRUCKS IN GREAT BRITAIN

Curve *A*—Ratio of pay load to unladen vehicle weight
Curve *B*—Cost of vehicles per long ton of pay-load capacity
Curve *C*—Maximum limit of pay load for a single vehicle
Curve *D*—Maximum limit of pay load for six-wheel vehicles
Curve *E*—Maximum limit of pay load for four-wheel vehicles

Were it possible to save half the weight of the body floor, the total saving would be equivalent to approximately 1 per cent of the laden weight. From the standpoint of the large operator there are certain drawbacks. Periodic overhauling may be carried out more economically by separation of the body and chassis. The maintenance of large numbers of vehicles of a similar type can be most economically achieved by means of a floating supply of bodies, units such as engines and gearboxes. Approximate calculation shows that the provision of an extra easily detachable body effects a saving of $1100 per annum in capital charges and license fees for a fleet of one hundred vehicles.

ENGINES

The high cost of fuel (38 cents per gal), in conjunction with the limitation upon vehicle weight and size, has resulted in a tendency toward the use of small cylinder capacity, and for the larger vehicles has stimulated the development of the compression-ignition engine. The limitations on vehicle length have also exerted their influence, and have necessitated the provision of engines suitable for forward control with the auxiliaries mounted wholly on the near side.

Maximum brake horsepower varies from 80 to 115 for single-deck buses accommodating from 30 to 34 passengers, and from 105 to 120 bhp for double-deck buses accommodating from 48 to 60 passengers. Most of these buses weigh the maximum permitted by the regulations and thus have a power ratio of from 8.9 to 12.2 bhp per long ton (2240 lb) for single-deck chassis and from 10 to 11.4 bhp per long ton for double-deck chassis. In the case of goods-carrying vehicles the range is more varied on account of the greater diversity of pay-load capacities.

The general trend of gasoline-engine design in recent years has been toward the use of higher compression ratios, and, as a result of improvement in engine mounting, a return to the four-cylinder type for the smaller sizes. Both changes give an improved specific fuel consumption. Of the trucks shown in Fig. 4 with less than 22,400-lb pay-load capacity, 52 per cent have four-cylinder engines, whereas in the case of the larger vehicles, 30 per cent have four-cylinder engines, 16 per cent have five-cylinder engines, and 54 per cent six-cylinder engines. The outstanding development, however, is the rapid growth of the Diesel engine, interest in which commenced in 1928 with the introduction of a number of Mercedes-Benz vehicles and engines of German origin. By 1934, 4317 trucks and 2397 passenger-carrying vehicles were equipped with Diesel engines, and by 1937, these figures had increased to 7107 and 12,997, respectively.

TRANSMISSION

The major problems associated with the transmission to the road wheels of the power developed by the engine are inherent in the nature of the internal-combustion engine, and are centered in the provision of a variable torque ratio together with a means of coupling the power from the engine smoothly to the road wheels without jerk. The universal solution of this

problem has been shown in various forms of automatic and semiautomatic transmission, although only two, namely, the fluid transmission (see MECHANICAL ENGINEERING, August, 1938, pages 631) and the torque converter, have achieved quantity production. However, the orthodox sliding-tooth gearbox has the merits of simplicity and cheapness.

BRAKING

The standard of braking required from commercial vehicles has been raised continuously, largely because of the tremendous advance in this respect in the private car. The density of traffic on the roads renders it increasingly necessary that all vehicles should be capable of a similar rate of retardation, as only by this means can a continuous and even flow of traffic be safely maintained. The improvements which have made possible the high standard of unassisted brake performance in smaller vehicles are divided between those directed to the elimination of lost motion in the linkage arising from stress distortion, and the use of self-energizing shoe systems. The former constitute an improvement in all circumstances, whereas the latter may, and often does, involve unreliable brake performance by reason of the multiplied effect of changes in the coefficient of friction of the brake linings.

The braking systems of the larger freight and passenger motor vehicles in Great Britain are almost wholly vacuum-operated on the servo principle. Power brakes of the positive type have been practically unknown, although it is probable that some move will be made in this direction during the next few years.

BODY ENGINEERING

The design and construction of bodywork has now become an engineering matter, largely because of the extreme lightness necessary to insure maximum seating capacity with the degree of comfort now provided for passengers. However, there is little that is worthy of comment in either the technique or construction of truck bodies. There has been some tendency during recent years to attempt the use of light alloy bodies for the ordinary truck. The extensive use of this form of construction, however, has been retarded by its high cost.

The original method of construction of bodies for passenger buses was based on the technique of the carriage builder. This technique persisted until shortly after the World War when the flitched composite type of body was introduced. In 1930 the so-called all-metal construction was instituted. Further improvement in this method resulted in a metal framework loaded with timber so that the paneling and fittings may be attached in the orthodox manner. This form of construction proved very satisfactory, and has been extensively used and copied. Approximately two thirds of the bus bodies built in Great Britain today are of this type.

Lightweight Passenger Rolling Stock

By WILLIAM A. STANIER

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NO ATTEMPT is made in this paper to compare British with American practice. The requirements are different. Variations in climatic conditions alone necessitate an entirely different practice and the restrictions imposed by the smaller loading gage (clearance diagram) in Great Britain call for an entirely different treatment. Also, largely owing to high platforms at the stations, the maximum width over the cylinders of a locomotive is 9 ft and the maximum height 13 ft, 6 in., but generally only 13 ft, 1 in. The maximum weight on an axle is 50,000 lb, and this limits the tractive effort of a six-coupled engine to about 40,000 lb. The maximum weight of a train is therefore not more than 600 long tons (2240 lb), so that to enable a reasonable number of people to be carried with the comfort necessary for comparatively short runs, it has been the practice to build coaches 60 ft in length and weighing 30 long tons.

In the past this was achieved by having a steel underframe and a body frame of wood with wooden paneling and roof, but for many years now the general practice has been to have a heavy steel underframe on which is mounted a wooden-frame coach body sheathed in steel and with a steel roof. Since 1932, however, serious attempts have been made to reduce weight by new methods and departure from the traditional British standard form of construction is gradually taking place. The introduction of electric welding and the availability of suitable high-tensile steels have been the cornerstones of recent progress, and have permitted a freedom in design formerly unattainable.

LATEST FORM OF DESIGN

In the new vehicles which were being built at the time this paper was written, still further development along the lines of all-steel construction and spot welding for body panels was made. The separate identity of the body as distinct from the underframe was finally abandoned and the method of design already tentatively adopted in previous developments was carried to its logical conclusion.

The design of underframe and body is based on the Vierendeel truss, which is now in considerable use for bridge trusses built of reinforced concrete or welded steel. It consists in a simplified form of a rigid frame incorporating parallel top and bottom booms (chords) with equal sections, and a number of vertical columns which are rigidly connected to the booms, to

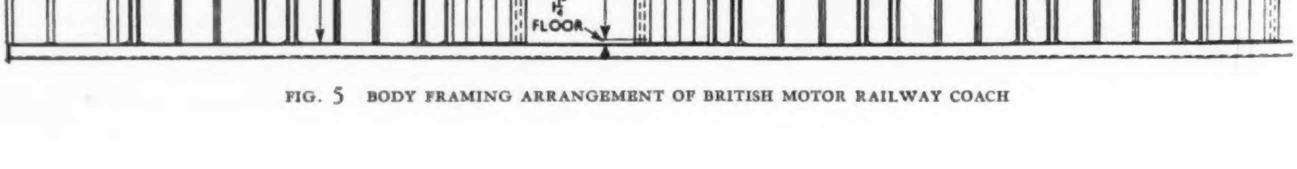

FIG. 5 BODY FRAMING ARRANGEMENT OF BRITISH MOTOR RAILWAY COACH

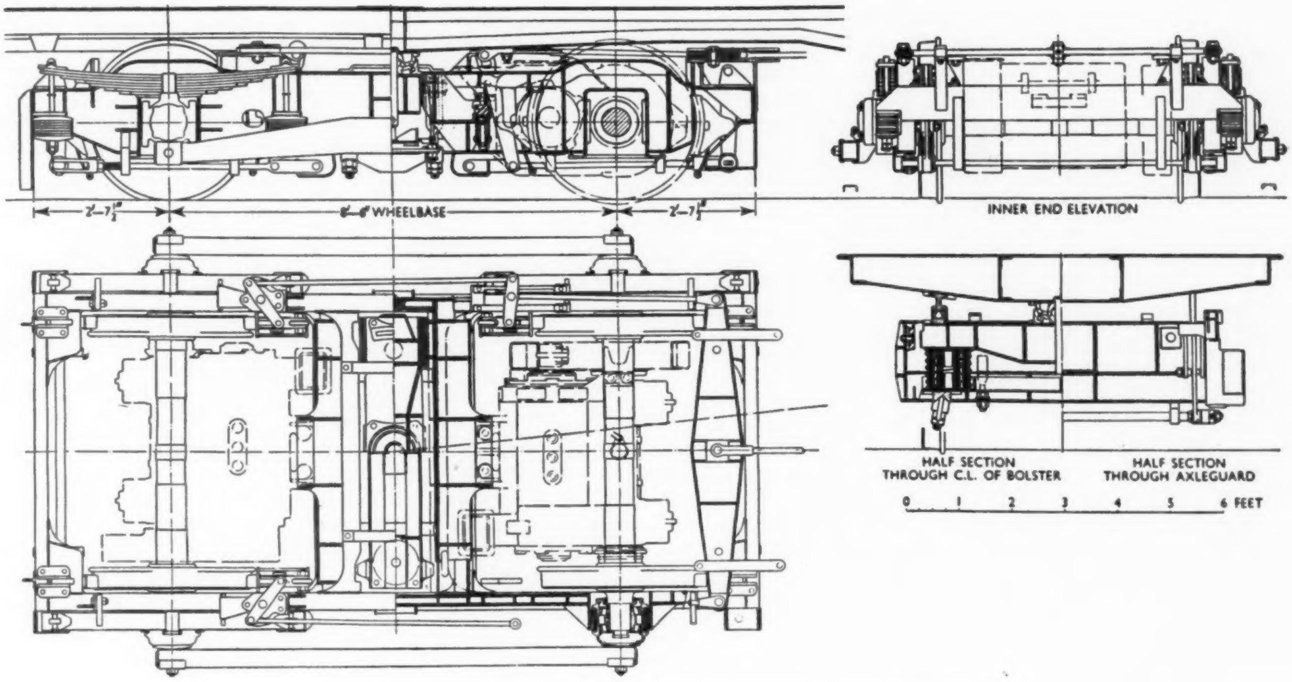

FIG. 6 MOTOR TRUCK OF A NEW TYPE OF BRITISH RAILWAY COACH

transmit bending moments as well as tension, compression, and shear. The working out of this form of truss, and its application to rolling stock, was undertaken in the design office of the London, Midland & Scottish Railway.

Fig. 5 shows the body frame unit of this stock, and it will be seen that if panels and light-section subsidiary members are left out of account the underframe, body side, and roof resemble the Vierendeel truss in general form. The panels are $^1/_{16}$ in. thick, and where they are unsupported over any considerable area it may be assumed that their resistance to buckling will not be great enough to justify taking it into account. Their presence, however, does add to the factor of safety of the whole structure. Regarding the body in this manner, the main underframe members form the bottom boom of the truss, the roof structure forms the top boom of the truss, and the body-side pillars perform the functions of the columns.

TRUCKS

The bogies (trucks) follow the usual lines of London, Midland & Scottish passenger-coach bogie design. Fig. 6 shows a motor bogie and Fig. 8 a trailer bogie. In the fabrication by welding of these bogies it has been found desirable to give special attention to the junction between the solebars (side-sill) and cross members at the point marked X in Fig. 8. The gussets have been designed to reduce concentrations of stress at corners and at the same time to leave the joints as strong and flexible as possible. It will be noted that the gussets are not butt-welded to the members but overlap them, this method having been found to produce a more reliable joint. The free edges are curved to reduce rigidity. A saving in weight in the bogies has also been effected by using a smaller wheel. This is 3 ft in diameter on the new coaches as compared with 3 ft, $7^1/_2$ in. on the older types.

CONSTRUCTION SHOP

In considering the layout of the assembly shop shown in Fig. 7, it is important to note that although the conditions of limited production prevail, the necessary output being only three coaches per week, unit assembly has been achieved on new lines, but based to some extent on the construction of the old type of wooden car. The unit-assembly method was adopted although the process had to be introduced into shops already engaged in the construction and repair of vehicles of the normal type, and machinery has been installed best suited to give economical production. The principal units which are built up on special jigs prior to being assembled into the complete coach are body sides, internal draft screens, motorman's and guard's partitions, coach ends, and roof.

To enable a progressive layout to be achieved one side of the car is put on in the No. 1 position, shown in Fig. 7, and after this has been secured and welded, the car is moved into No. 2 position, where the other side is similarly treated. After this, the motorman's and guard's partitions, where required, are placed in position, the joints between the outsides of the parti-

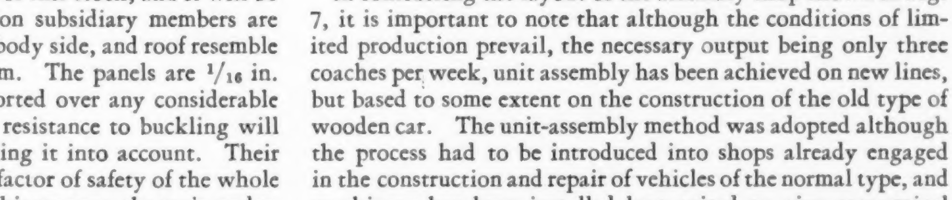

FIG. 7 ASSEMBLY-SHOP LAYOUT OF THE LONDON, MIDLAND & SCOTTISH RAILWAY

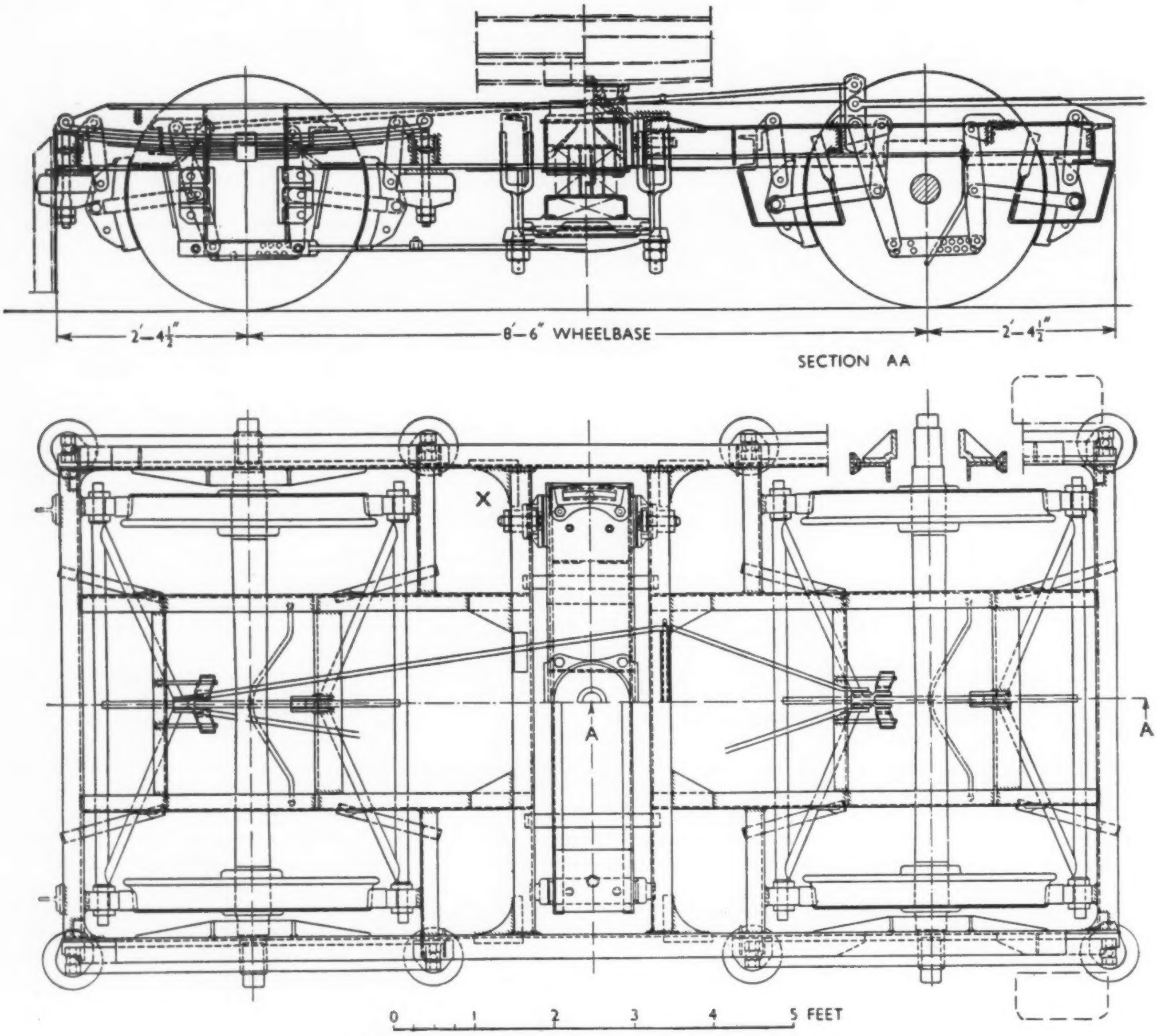

FIG. 8 TRAILER TRUCK OF A NEW TYPE OF BRITISH RAILWAY COACH

tions and the body pillars being riveted. The coach flat ends are then erected and the pillars welded to the headstock (side-plate) and solebars (side-sills). For fitting the roof the coach is moved into the appropriate position, and the completed roof, already raised to a suitable height, is moved over the coach and lowered. The interior fitting represents the final construction stage and the fitting of timber packings in the roof and body sides, to take the wooden interior paneling, follows standard British practice to a considerable extent.

It will be seen that the vehicles last described represent the latest stage in a process of development, the object of which has been primarily to reduce weight without sacrifice of strength. Although applied to suburban rolling stock in the first place, the principles involved appear equally applicable to main-line stock, but after each new step forward a period of consolidation is desirable in which the behavior of the vehicles in service is watched. It is impossible at this stage to say anything on relative costs, which was not the prime consideration in initiating the new methods.

Mechanical-Engineering Problems in Marine Transport

By STERRY B. FREEMAN

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TRANSPORT by water is the cheapest medium of transportation. The sea, according to the author, is the best and cheapest road; no mechanical problem is involved in keeping its surface renewed. As regards the ship, there are no tires to wear out and the annual repair bills are not as heavy as they would be for land-transport vehicles carrying the same tonnage over the same period. Necessary overhauling, repair work, and emergencies that arise are dealt with by the ship's own staff when they are not engaged as watchkeepers on the plant at work.

Marine transport covers, of course, both passenger and cargo services and is carried on by passenger ships, passenger and

cargo ships, cargo liners, and so-called "tramps." The demarcation between these different types is difficult to define. Speeds are 25–32 knots for the express liner; 20–25 knots for the cabin liner; 16–20 knots for passenger ships; 12–18 knots for cargo liners; and lower speeds for tramp ships and coasters. While the public desires the high speed and comfort that can only be obtained in large ships, these vessels have a number of limitations which result in correspondingly high charges. Few drydocks can take these very large ships; they cannot pass through the Panama and Suez canals; and, unless government assistance is invoked, their insurance is a difficulty. Separation of passenger and cargo traffic has become steadily more marked, and the very large ships carry practically no cargo.

The resources of mechanical engineering are being increasingly drawn upon by the great increase of care for human life and the addition of many amenities in the provision of food, shelter, heating, ventilation, air conditioning, lighting, and precautions against the danger of fire. The machinery to provide these requirements includes such auxiliary plants as electric generators, motors, refrigerators, wireless stations, direction finders, depth-sounding equipment, motorboats, and fans of various types. In addition to fulfilling every requirement as regards safety and accommodations, a new demand is made on the engineer in the matter of freedom from vibration. In the larger ships of the last generation, it was impossible to keep ink in the inkstands or to write letters at the afterend of the ship; the vibration was too great. In modern ships, thanks to further stiffening of the structure and refinements in propeller design, this vibration bogey has been laid.

The weight of ships has been decreased by the use of special steels. This saving, together with the adoption of Diesel engines for propulsion or of turbines and water-tube boilers working at high pressure and superheat, has radically reduced the machinery space required, thus setting free large spaces for passengers' use and enjoyment. The elevators, swimming pools, motion-picture theaters, and other equipment already described, add largely to the mechanical problems of the engineering staff. The provision and maintenance of suitable pumps, pump connections, steam-heating coils and connections, refrigerating plants, is the engineer's work. The design of coastal ships from 500 to 2000 tons and their mechanical equipment presents special problems, and the limitations of dimensions and of draft, with their effect on power and speed, obviously need special consideration.

If the cost of the fuel were the only criterion of the speed at which marine transport should be carried on, there would be no justification for building ships to operate at speeds above 9 or 10 knots. It is extremely difficult to estimate the value of speed. For passenger services, in these days of radio and telephones, it has generally no intrinsic value, and is just one form of luxury or sport. In cargo services the shipper wants his cargo delivered as soon as possible in order to receive early payment for his goods. Freight rates could be cheaper if shippers would be content with slower speeds. The number of voyages a ship on a regular schedule can make is a measure of the amount of cargo she can carry and money she can earn. Powerful machinery and the consequent high fuel consumption are, however, expensive although they are fully justified if the additional speed enables the service to be carried on with fewer ships, or to attract cargo from other lines or forms of transport. Regularity is invaluable for ships running on a published schedule, and as delays in harbor and by weather upset sailing times a reserve of speed is necessary to make up lost time.

It is obviously unwise to run ships at high speeds from port to port, and then to detain them unduly while loading and discharging cargo after arrival. The problem of supplying ade-

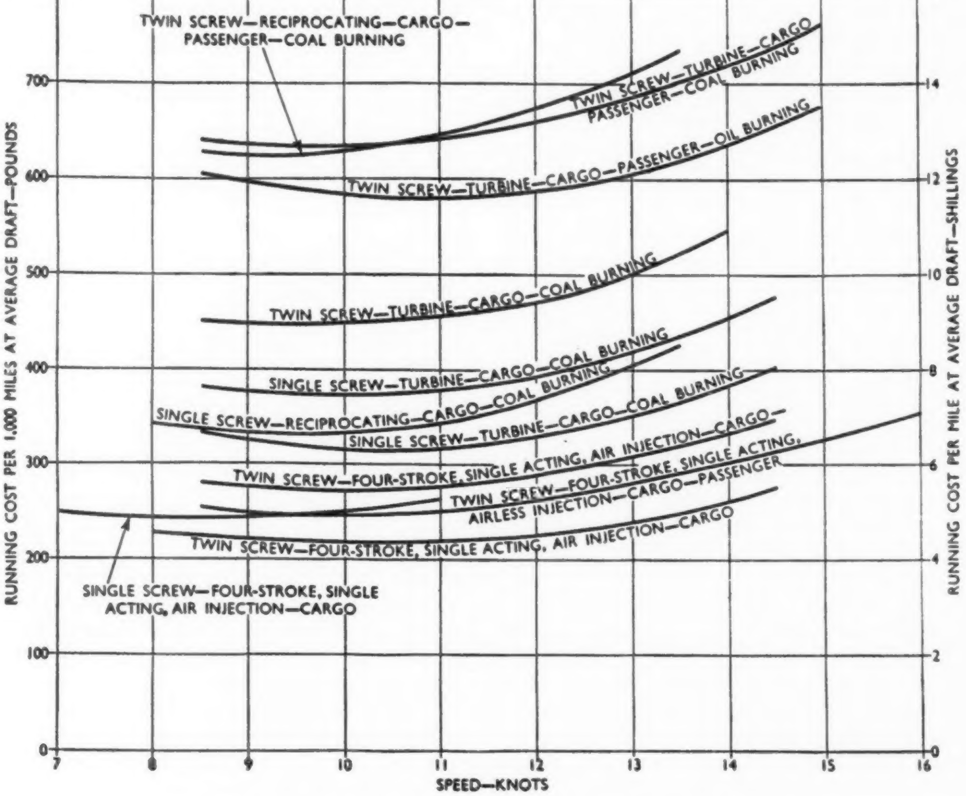

FIG. 9 RUNNING COSTS OF VARIOUS SHIPS AT AVERAGE DRAFT
(Includes fuel wages, food, stores, repairs, and upkeep.)

quate and suitable cargo-handling equipment is as important as that of the propelling machinery.

For a voyage the expense in fuel varies as the square of the speed, whereas daily expenses, such as food, wages, and stores, vary as the reciprocal of the speed. (See Table 1.) Consequently, at high speeds the rate of increase in the fuel expense is greater than the rate of decrease in the other expenses. At low speeds the converse is the case, and some speed will be found at which the total of these costs will be a minimum. This is obviously the speed at which the ship should be operated on ballast voyages if other more important considerations do not arise.

TABLE 1 ANALYSIS OF OPERATING COSTS OF TWO TYPES OF SHIPS

Item	Cargo liner of 10,500 gross rated tonnage, per cent of running cost	Intermediate passenger liner of 16,000 gross rated tonnage, 200 passengers, per cent of running cost
Establishment charges, stevedorage, agents' commissions, etc.	34.80	27.00
Interest and depreciation	26.30	27.00
Fuel	17.25	15.60
Dues	7.28	7.80
Crew's wages	6.67	8.50
Food (crew and passengers)	1.38	9.50
Hull upkeep	1.63	1.40
Machinery upkeep	2.70	1.80
Deck and engine stores	1.90	1.40
Total running cost	100.00	100.00

Engineers are quite ready to use that form of motive power which is correct and most suitable for the purpose in view. In the larger ships a combination of different types is usually employed, for example, steam boilers and turbines for propulsion, Diesel engines to generate auxiliary power, and electric motors to operate isolated and distant units such as the windlass and the steering gear. In smaller ships the service to be performed will indicate whether steam or Diesel engines will best cover the whole of the requirements. Particulars of engine economy governing marine transport are listed in Table 2.

The outstanding factors in deciding whether coal or oil should be used as fuel are the questions of bunker space and weight. For equal weights, coal takes up about 17 per cent more space than oil, and provides about 33 per cent fewer heat units. In the majority of cargo ships, all available space is wanted for cargo purposes, and any weight in the bunkers shuts out a corresponding amount of freight. In mixed passenger and cargo ships there is the further disadvantage of delay and discomfort in bunkering coal. In the large fast passenger ship, with a rapid turn-around at each end, coal is practically impossible. The oil-fired water-tube boiler is a compromise, and with a cheaper class of oil for boiler use, the increased amount to be carried and burned may be faced, since this oil can be carried in the double bottom and does not, as a rule, require special bunkers above the double bottom.

It can be ascertained whether the power required to drive a ship has been economically applied by the use of the so-called Admiralty coefficient, $D^{2/3}S^3 \div \text{hp} = C$, and the fuel coefficient, $D^{2/3}S^3 \div$ fuel tons per day $= F$, where D is the displacement of the ship in tons, S the speed in knots, and hp the horsepower. As a result of prolonged trials, both at sea and in tank tests, these coefficients, in the hands of competent and experienced engineers, can be used to measure the efficiency of the ship and her machinery.

The turbine is clearly the right plant for the highest powers, but its use involves high pressures, high superheat, oil-fired, water-tube boilers, elaborate feedwater and air-heating systems, and great care regarding the purity of the feedwater. The use of the water-tube boiler has necessitated a new technique of water treatment, and the engineer in charge needs to know a certain amount of the chemistry of water to deal adequately with the feed supply. These modern boilers or steam generators offer a greatly increased proportion of radiant heating surface, resulting in a high rate of evaporation and a consequent saving of space. The problem is to insure complete reliability with these advantages.

The greatest problem facing the marine Diesel-engine builder has been to reduce the weight in relation to the power, and so to reduce the cost per horsepower. The single-acting four-stroke crosshead engine, with its cooling and scavenging stroke between each power stroke and consequent low consumption of fuel and lubricating oil, has had to give way to the single-acting, two-stroke-cycle engine. The adoption of high supercharging for the four-stroke single-acting engine has delayed the change, but the ratio of weight to power is against the four-stroke engine. For higher powers the two-stroke trunk-piston engine, running at comparatively high speeds of revolution, makes a suitable propelling plant for passenger ships where a low contour of machinery is necessary, while for ships in which a short engine room is desirable the opposed-piston two-stroke, or the two-stroke double-acting engine has come into favor. As in turbine practice, various devices have been used to reduce the rate of revolution between the oil engine and the propeller.

TABLE 2 GENERAL PARTICULARS OF ENGINE ECONOMY GOVERNING MARINE TRANSPORT

Type of engine	Over-all thermal efficiency, per cent	Fuel consumption, per shp per hr: Coal	Oil
Reciprocating engines using saturated steam	11	1.85	1.29
Reciprocating engines using superheated steam	13.5	1.50	1.05
Reciprocating engines having the exhaust steam from high pressure reheated	16	1.27	0.88
Reciprocating engines and exhaust turbines using superheated steam	16	1.27	0.88
Turbines and gearing working at low pressures and temperatures	16	1.27	0.88
Turbines and gearing working at high pressures and temperatures and using oil-engine-driven generators for auxiliary power	24–27	..	0.57
Oil engines with air injection of fuel	35	..	0.40
Oil engines with airless injection of fuel and high maximum pressure	40	..	0.355
Oil engines with waste-heat boiler	37	..	0.380
Oil engines with heat recovery on Still system, or with abnormally high compression pressures	43	..	0.330

For the purpose of calculating the figures in the table, the following figures have been taken for calorific value of fuel, boiler efficiency, and mechanical efficiency:

	Coal	Oil
Calorific Value of Fuel		
Available heat in fuel, Btu per lb	15,000	19,000
Probable average value, Btu per lb	12,500	18,000
Boiler Efficiency		
Cylindrical boilers, per cent	65–75	77–82
Water-tube boilers, per cent	75–80	85–88
Mechanical Efficiency of Engines		
Reciprocating steam, per cent	90 approximately	
Oil engines, depending upon type, per cent	72–88	

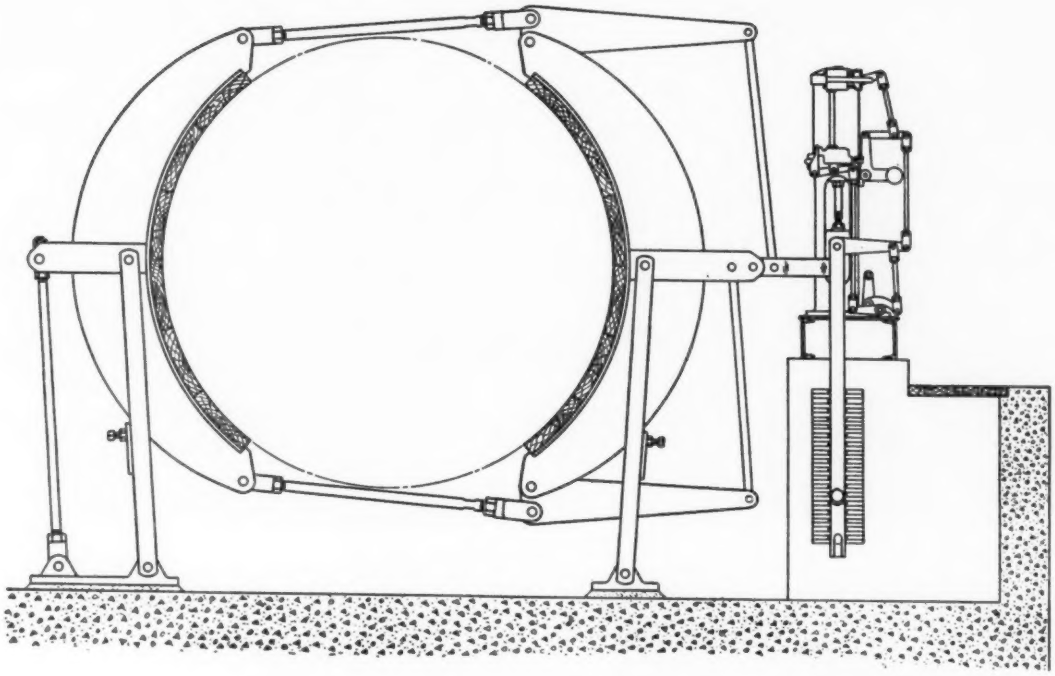

FIG. 1 GRAVITY-AIR POST BRAKES

CANADIAN MINE HOISTS

A Description of Several Notable Hoists With Details of Their Construction

By H. V. HAIGHT and G. M. DICK

CANADIAN INGERSOLL-RAND COMPANY, LTD., SHERBROOKE, P. Q., CANADA

GOLD mining has developed rapidly in Canada in the last decade. At the beginning of 1930 there were about 50 gold mills in operation, while in the middle of 1939 there were approximately 150. In addition, several mills, which were opened, operated for a period but have since closed down. Other mining activities during this time included considerable development of copper, nickel, and asbestos mines.

Naturally, hoisting equipment played a prominent part in this development. A majority of the hoists installed have been built in Canada. They have been made possible as a result of the progressive ideas on hoist design and the courage to adopt them on the part of mechanical superintendents of some of the Canadian mines. The general result has been a development in mine hoists in Canada that presents features of particular interest to engineers.

CLASSIFICATION OF HOISTS

For the purpose of this paper, mine hoists have been classified under the following headings:

Main hoists are used in main shafts, internal shafts, and slopes to raise the ore to the surface or to a main station underground.

Auxiliary hoists are used on winzes and sublevels for sinking, handling timber, and other similar purposes.

Slushing hoists are utilized for scraping and loading purposes.

DESIGN FEATURES AND TRENDS

Brakes. Band brakes, usually with asbestos brake lining, are used on practically all slushing and auxiliary hoists and on a few of the smaller type of main hoists. Nearly all main hoists are equipped with post brakes of the parallel-motion type. Fig. 1 shows a set of gravity-air post brakes. Whether operated by air or hydraulic pressure, these brakes are arranged to be set by weights and released by power. The brake blocks used on them may be made of asbestos or of basswood. Advantages of post brakes are that they do not drag or grab when loads are being lowered and hold equally well in either direction of travel. Parallel-motion brakes give practically equal wear on all parts of the brake blocks.

Clutches. The three general types of clutches used on mine hoists may be classified as positive, band-type friction, and plate-type friction. Positive clutches are used on the smallest hoists because they are simple and compact, and on the largest hoists because they are safe. Fig. 2*a* shows a close-up view of a sliding-gear type of positive clutch. In some cases, instead of the complete spur-gear arrangement shown, clutches use only two or four arms for the driving member. A face-gear type of positive clutch is illustrated in Fig. 2*b* and an internal-expanding type of positive clutch in Fig. 2*c*. Another kind of clutch used on the smallest to the largest hoists is the friction-type which has the advantage of fast operation. The plate type has

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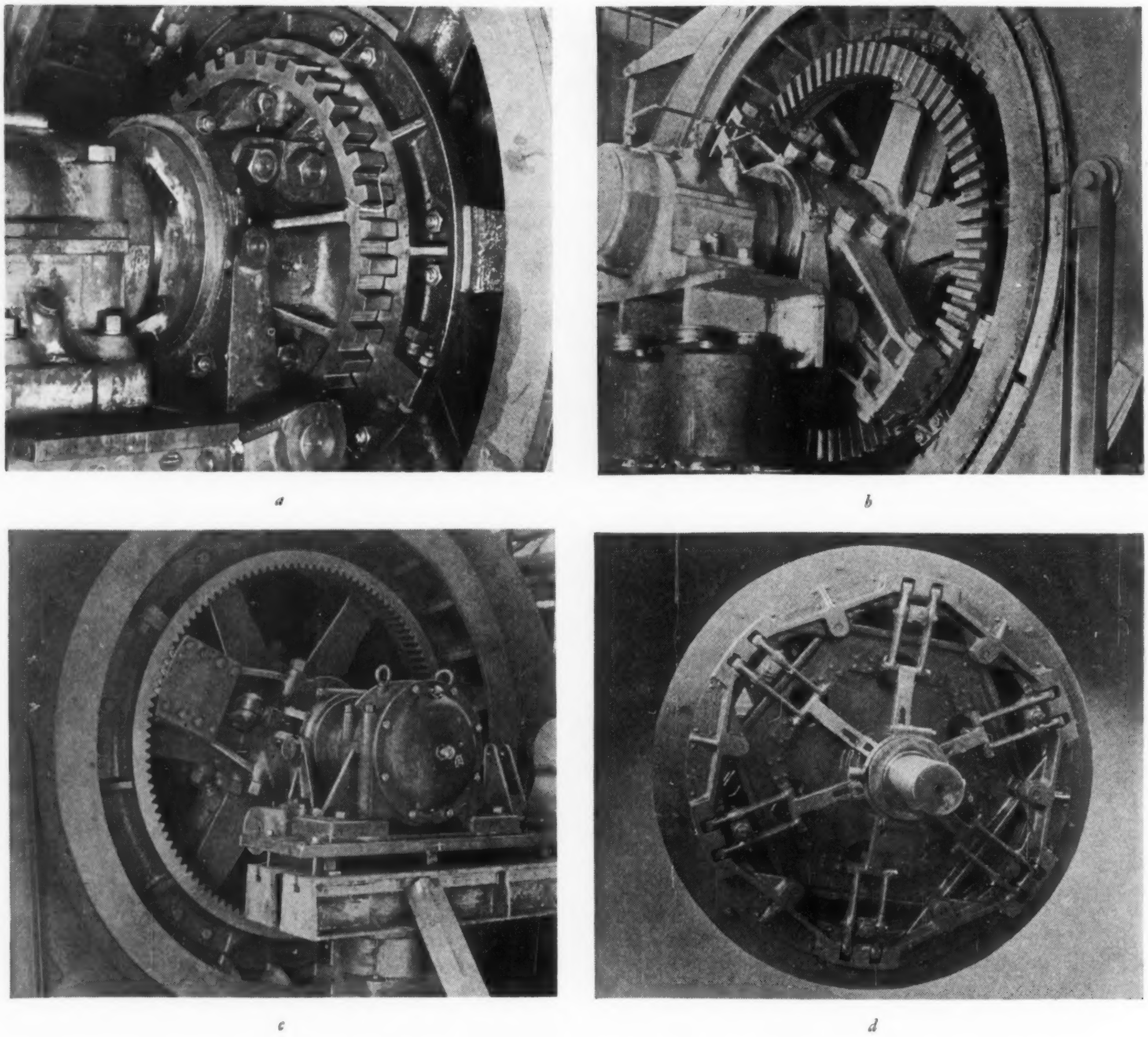


FIG. 2 FOUR TYPES OF CLUTCHES USED ON MINE HOISTS

almost replaced the band type because of the former's advantages, such as safety, because the load-holding parts are in multiple and the absence of "snubbing" action, which enables it to hold in either direction of travel and not to drag when released. A plate-type friction clutch is shown in Fig. 2*d*.

Power for Clutches and Brakes. The clutches and brakes of slushing, auxiliary, and small main hoists are usually operated by manual power through hand levers. Mining regulations do not permit the use of foot-operated brakes, except of course on slushing hoists. The larger types of main hoists depend on compressed air or hydraulic pressure to work the clutches and brakes, the choice of operating fluid depending upon the preference of the purchaser. When the main brakes are not controlled in this manner, it is customary to have a brake on the pinion shaft set by a weight in case of an emergency. Government regulations require that brake and clutch levers be so interlocked that both cannot be released at once, and, in the case of a single-drum hoist, prohibit the use of a clutch. Fig. 3 shows a sectional view of an air-brake engine, a feature of which is that there is compressed air on both sides of the piston. The pressure on top may be partly released to raise the weights. This dense-air operation results in smooth, positive action, so that no springs or oil dashpot are needed.

Operating Power. Practically all main hoists are driven by electric motors, only one main hoist driven by steam having been installed in Canada during the last 10 years, so far as is known. Except in the case of a few very large main hoists, all motors run on alternating current. With slushing hoists and auxiliary hoists, either electricity or compressed air is used, the latter medium being used almost exclusively in coal mines where compressed air is also utilized for many other purposes.

Gearing. The great majority of main hoists have single-reduction gearing of the double-helical type encased in an oil-tight case. A few small main hoists have double-reduction gearing, and a few large hoists have direct drive. All gears are made of steel. Slushing and auxiliary hoists usually have double-reduction gearing.

Since many of the features just described, as well as several others of distinctly Canadian design, are embodied in several

installations made within the last ten years, a few of these hoists will be described here.

ORE HOIST AT LAKE SHORE MINES

Illustrated in Fig. 4 is a hoist built by Canadian Ingersoll-Rand Co. and installed in the Lake Shore Mines, Kirkland Lake, Ontario, in 1931. Another installation of the same type was made here in 1935. The principal dimensions, speeds, and capacities are given in Table 1. The maximum rope pull (not including acceleration) is made of weights of ore, 12,000 lb; skip, 10,000 lb; and rope, 18,000 lb. This gives a total load on one rope of 40,000 lb.

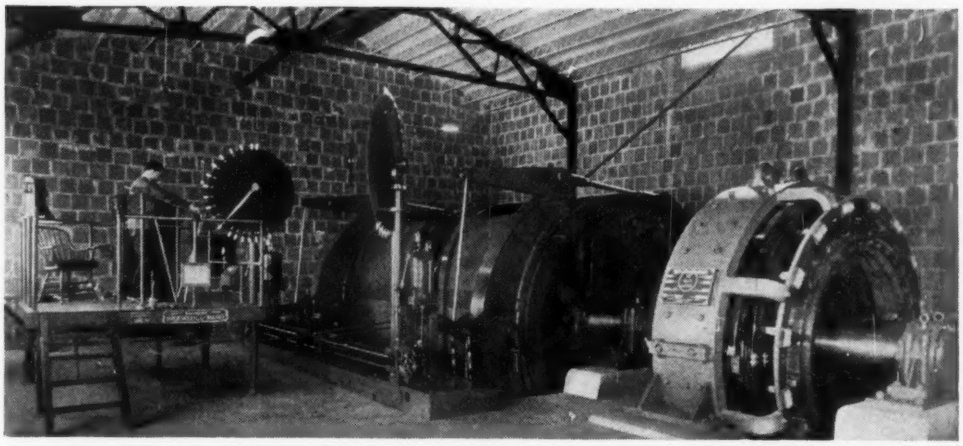


FIG. 4 ORE HOIST AT LAKE SHORE MINES

The hoist is a direct-connected type, consisting of two drums in line on a drum shaft, and a direct-current motor armature mounted on an extension of this same shaft. The shaft is made in two sections, connected by means of a flanged coupling, one half of which is forged integral with each section of the shaft. The hollow drum shaft which weighs 17 tons has a hole bored through its entire length. Both the motor armature and one of the hoist drums are keyed to the shaft, while the other drum, driven by a clutch of the positive type, is free to rotate on the shaft.

The drums are of very rigid construction, consisting of end spiders of cast steel with H-section arms. Extending to the drum periphery, the spider forms part of the drum barrel, as shown in Fig. 5. The center portion of the barrel is made from rolled-steel plate, having cast-steel reinforcing rings riveted inside; and the two flanges and the barrel are fastened together by fitted bolts. Each drum is spirally grooved for the ropes. Since each drum weighs approximately 32 tons, the total inertia of the moving parts amounts to 2,600,000 lb-ft.[2]

The four bearings, which were supplied by the Canadian SKF Company, Ltd., and support the drum shaft, are the largest-capacity spherical roller bearings in Canada. This installation establishes an interesting precedent in hoist design, and follows the general tendency of designers of railroad equipment, electric motors, and such machinery, to use this type of bearing on heavy equipment. D. L. Cramp, mechanical superintendent of Lake Shore Mines, was responsible for the use of roller bearings on this pioneer hoist. These have been entirely successful and Lake Shore Mines now have five hoists equipped with spherical roller bearings.

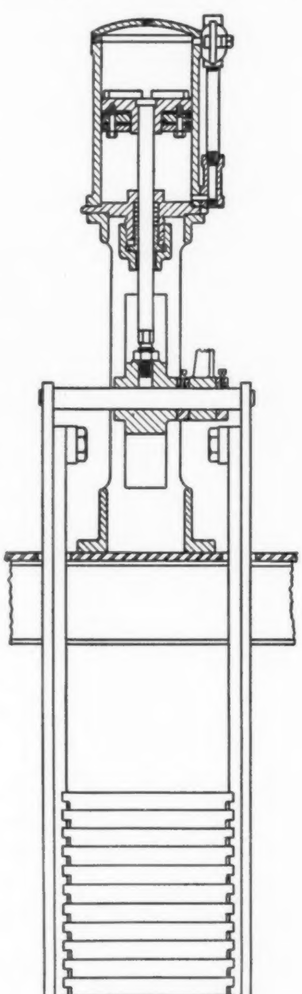


FIG. 3 AIR-BRAKE ENGINE

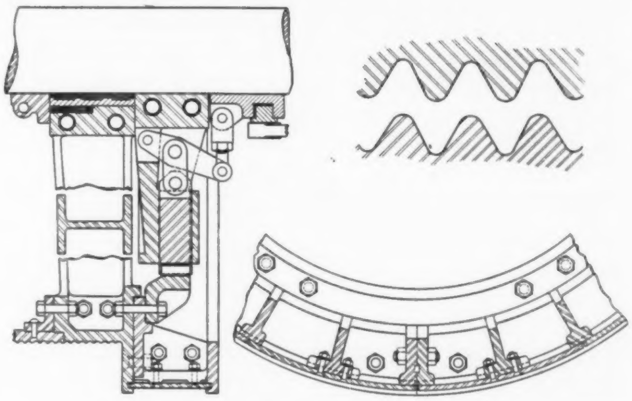


FIG. 5 LAYOUT OF DRUM FLANGE, BRAKE PATH, AND CLUTCH, AND PROFILE OF TEETH

The object of this development is to reduce friction, which is considerable when starting from rest and during acceleration. The peak loads are reduced in proportion resulting in saving in power charges, which are governed to a large extent by peak-load demands. Because the spherical roller bearings are much shorter than the ring-oiling bearings generally used in a hoist of this size, the length of the entire machine is reduced considerably. This reduction in length of drum shaft makes it possible to decrease slightly the diameter of the shaft, owing to its smaller unsupported length. Another valuable advantage which accrues from the use of spherical roller

TABLE 1 PRINCIPAL DATA ON HOIST AT LAKE SHORE MINES, KIRKLAND LAKE, ONT.

Diameter of each drum, ft.	10
Width of each drum, ft.	6
Maximum pull on one rope, lb.	45000
Diameter of hoisting rope, in.	$1^1/_2$
Maximum hoisting speed, fpm.	2000
Drum speed, rpm.	63
Motor horsepower.	1350
Maximum accelerating peak horsepower.	2700
Maximum depth from which ore is hoisted, ft.	4200

bearings is the decrease in the fleet angle of the rope, because the shorter spherical roller bearing between the drums brings the two drums closer together.

Compressed air is used to operate the brakes, which have nondistorting paths, shown in Fig. 5, a feature which was invented and patented by Mr. Cramp. The brake tread is made in twelve sectors, each secured in the center only and free to expand lengthwise in grooves in the drum flange and brake-path flange. Contact of the brake tread with these flanges is reduced to a minimum and ample ventilation is provided. With this design, there is no distortion of the brake tread due to heating, and consequently, no appreciable increase in diameter. No automatic take-up of the brakes is provided because it is not necessary.

The clutch used on this hoist, also devised by Mr. Cramp, is shown in Fig. 2*c*. It is an internal-expanding, positive clutch, consisting of an internal gear bolted to the drum spider and a driving member keyed and bolted to the shaft. There are two radial slots in this driving member, in which slide jaws, having teeth cut on their outer ends, operated by toggles and links connected to a sliding collar on the shaft. The sliding collar is actuated by arms on a rock shaft through a compressed-air cylinder controlled by a hand lever on the operator's platform. This type of clutch is much easier to "spot" than other types of positive clutches. Other advantages are the absence of a driving member to be moved endwise on the shaft on a hexagon or splines, absence of end thrust on the drum while the clutch is being engaged, and radial adjustment of the sliding jaws which makes it possible to set them tightly without lost motion.

The hoist is completely equipped with safety devices, including two Lilly hoist controllers which prevent overspeed, overwinding, and faulty retardation. One of these controllers may be seen at the base of the air-brake mechanism in Fig. 4. Brake regulator valves are also furnished, which, in conjunction with the Lilly controllers, prevent rapid application of the brakes on an emergency stop unless the skip is within a predetermined distance from the end of its travel. The operation of resetting the safety devices after an emergency stop is accomplished by pushing the brake hand levers a short distance beyond their normal travel, thus eliminating the necessity of the operator's leaving the platform or of having a special arrangement of resetting levers and mechanism. Traveling-nut limit switches of the screw type are also employed in connection with the electrical control.

Depth indicators, having 60-in-diameter dials mounted in front and driven by gears and shafts from the drum give a clear view to the operator of the drums and the ropes. Power for the hoists is supplied by a 1350-hp direct-current electric motor. The control equipment includes a Ward-Leonard-Ilgner flywheel set. The complete electrical equipment was supplied by the Canadian Westinghouse Company.

SURFACE MAN HOIST AT LAKE SHORE MINES

Fig. 6 shows a man hoist built by Canadian Ingersoll-Rand Company for surface use at the Lake Shore Mines. The interesting feature of this hoist is that only two bearings are used on the shaft, which supports both the drums and the armature of the 800-hp direct-current motor. Supporting the shaft in two self-aligning bearings eliminates any excessive loads due to deflection of the shaft and any uncertainty as to the actual loads imposed on the bearings. The electric equipment, including motor, was supplied by the Canadian Westinghouse Company, and the control equipment consists of a Ward-Leonard-Ilgner flywheel set.

The principal dimensions, speeds, and capacities are given in Table 2.

TABLE 2 PRINCIPAL DATA ON SURFACE MAN HOIST AT LAKE SHORE MINES

Diameter of hoisting drum, ft	12
Width of hoisting drum, ft	8
Diameter of counterbalance drum, ft	8
Width of counterbalance drum, in	$67^1/_4$
Maximum pull on hoisting rope, lb	41000
Maximum pull on counterbalance rope, lb	47200
Maximum hoisting speed, fpm	1800
Motor horsepower	800
Maximum accelerating peak horsepower	1600
Maximum depth from which men are hoisted, ft	4000

UNDERGROUND MAN HOISTS AT LAKE SHORE MINES

Fig. 7 shows another man hoist installed at Lake Shore Mines 3825 ft below the surface. This hoist, built by Canadian Ingersoll-Rand Company, also has its shaft carried by two spherical roller bearings. The gear is overhung, with its pinion shaft using two spherical roller bearings. Driven by a 500-hp electric motor, the hoist has two drums; the hoisting drum is 10 ft in diameter and 4 ft in width, and the balance drum is 8 ft in diameter and 3 ft in width. The brakes have a nondistorting path.

SURFACE ORE HOIST AT INTERNATIONAL NICKEL

The International Nickel Company of Canada, Ltd., has in operation at its Creighton mine, near Sudbury, Ontario, the largest hoist in Canada. This hoist was designed by the Allis-Chalmers Co., Milwaukee, Wis., and built by Canadian Allis-Chalmers, Ltd. A view of the hoist as installed is shown in Fig. 8.

This hoist is of the tandem type and makes the entire wind in one layer of rope and yet with a small fleet angle, which is kept down to 1 deg 25 sec even though the horizontal face of each drum is more than 13 ft. The principal dimensions, speeds, and capacities of the hoist are given in Table 3.

TABLE 3 PRINCIPAL DATA ON SURFACE ORE HOIST AT INTERNATIONAL NICKEL, CREIGHTON, ONT.

Diameter of drum at small end, ft	12
Diameter of drum at large end, ft	25
Maximum rope pull, lb	53000
Diameter of hoisting rope, in	$1^3/_4$
Maximum rope speed, fpm	3000
Drum speed, rpm	38.2
Maximum hoisting distance, ft	4513
Weight of skip, lb	10000
Weight of ore, lb	18000
Weight of rope, lb	25000
Output, tons per hr	250

Two motors—each 1200 hp with motor generator set and Ward-Leonard controls.

The two drum shafts are each 30 in. in diameter through the drums and are hollow-bored and periscope-inspected for smoothness. Each shaft is 36 ft long and weighs approximately 70,000 lb when finished. These shafts are $3^1/_4$ to $3^3/_4$ per cent nickel-steel forgings, free from seams, ghost lines, or flaws.

The drum shells, because of their size, are made in a large number of sections bolted together. One complete drum assembly weighs approximately 242,000 lb. The forward drum, that is, the one toward the head frame, is keyed to its shaft and carries the underwound rope, while the back drum is clutched and carries the overwound rope. This latter drum is driven by a face-gear-type clutch, as shown in Figs. 2*b* and 8, which is actuated by an oil-operated clutch engine. Each complete drum shell is supported at each end by a cast-steel spider of special design to secure correct transfer of the loads from the shell to the shaft. Each drum is served by a welded-structural-steel post brake having a diameter of 15 ft and a face of 21 in.

The gears and pinions are of the Sykes continuous herring-bone cut-tooth type, consisting of one main gear on each drum shaft with an idler gear between the two tying them together, and two pinions, one meshing with each drum gear. The entire gear train is totally enclosed in a gear case and the gears run in a suitable lubricant. It is sectionalized for removal of the pinion shafts without disturbing the entire top of the casing, and is provided with horizontal inspection doors over each pinion, and with a door for inspecting the idler-gear arrangement.

The oil for operation of the clutch and brake engines is supplied by an oil-pressure system. This consists of an oil-storage tank, a pressure tank, and duplicate motor-driven rotary-gear pumps with suitable control, all built as a unit. This pressure system can deliver the required quantity of oil up to 200 lb per sq in. for the fast operation of the brakes and clutch with one pump running, the second being held in reserve. Since no stuffing boxes or valves are used, maintenance of the system is practically eliminated.

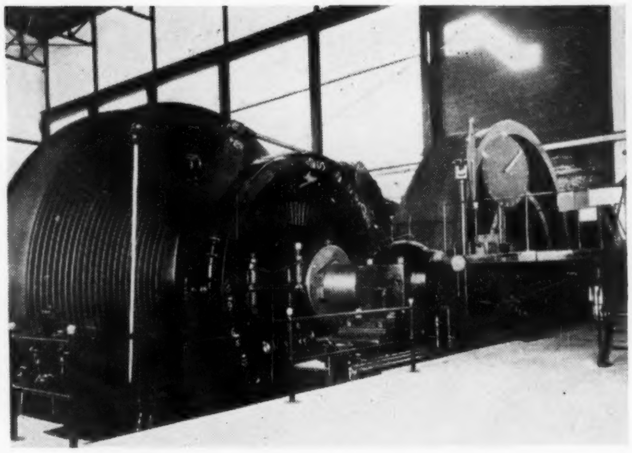


FIG. 8 SURFACE ORE HOIST AT INTERNATIONAL NICKEL

UNDERGROUND ORE HOIST AT INTERNATIONAL NICKEL

Fig. 9 shows an ore hoist built for International Nickel Company of Canada, Ltd., for its Copper Cliff, Ontario, mines

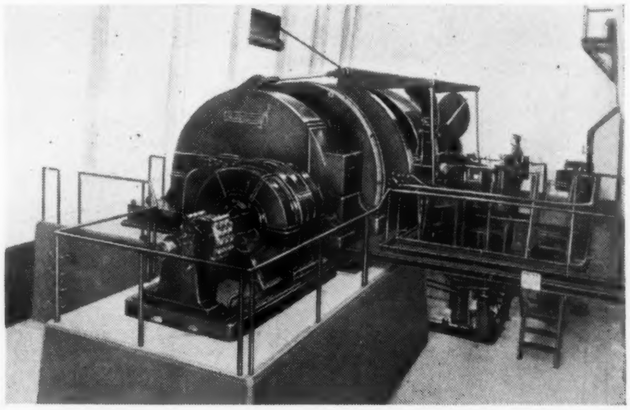


FIG. 9 UNDERGROUND ORE HOIST AT INTERNATIONAL NICKEL COMPANY'S FROOD MINE

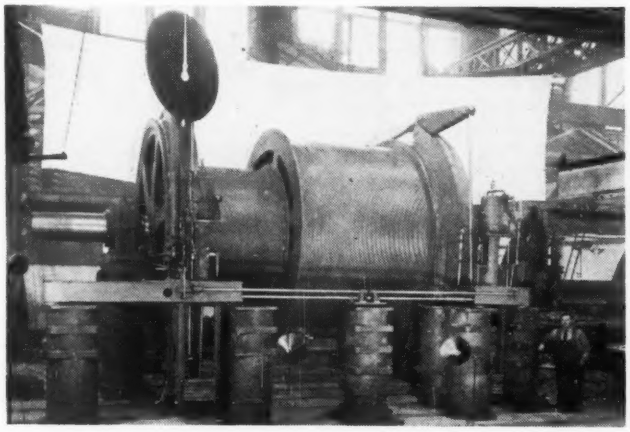


FIG. 6 SURFACE MAN HOIST AT LAKE SHORE MINES

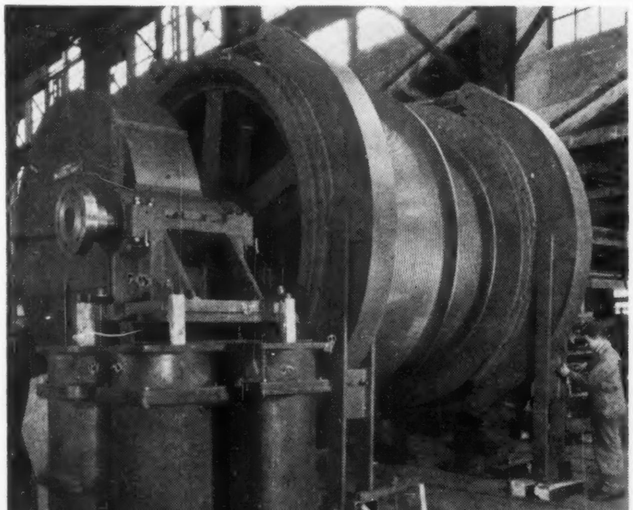


FIG. 7 UNDERGROUND MAN HOIST AT LAKE SHORE MINES

by Canadian Ingersoll-Rand Company. This double-layer-rope hoist, the largest for underground use ever installed in Canada, is 2800 ft below the surface at the Frood mine and is built in sections which made it possible for the parts to be taken down the main shaft and through the underground workings to the hoist room. In addition to the sectionalized construction, other special features include a gravity-flow oil system for the bearings of the drums and pinion shafts instead of the ring-oiling bearings generally used; a clutch of the face-gear type (Fig. 2*b*) with the driving member sliding on a hexagon on the shaft, as shown in Fig. 10 on the following page; duplicate oil pumps supplied by an accumulator operate the brakes and clutches; and the pinion shaft is coupled to the motor shaft by a rigid coupling.

Table 4 summarizes the principal dimensions and weights.

TABLE 4 PRINCIPAL DATA ON UNDERGROUND ORE HOIST AT INTERNATIONAL NICKEL, COPPER CLIFF, ONT.

Diameter of each drum, ft	12
Width of each drum, ft	$4\frac{2}{3}$
Maximum rope pull, lb	40000
Diameter of brake path, ft	13
Motor horsepower	600
Maximum accelerating peak horsepower	1150
Rope speed, fpm	1000
Weight of drum shaft, lb	30000
Weight of each drum, lb	60000
Drum speed, rpm	26
Diameter of rope, in	$1\frac{3}{4}$
Depth of hoisting, ft	2100

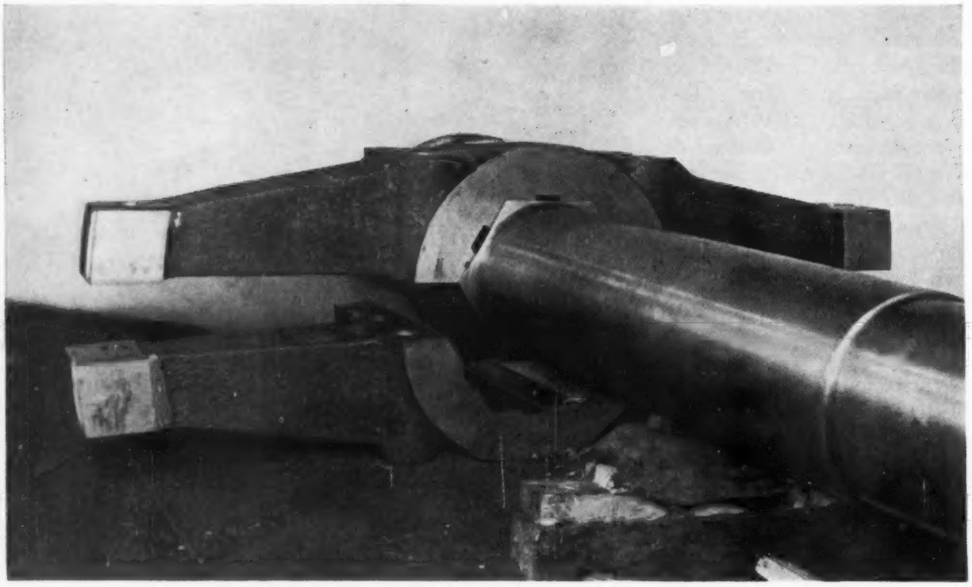


FIG. 10 CLUTCH DRIVING MEMBER OF HOIST SHOWN IN FIG. 9

the load either balanced or unbalanced. The unbalanced torque is 348,840 ft-lb, while the balanced torque is 252,280 ft-lb. The welded-plate post brakes and the tooth clutch are both hydraulically operated, the geared pump furnishing oil under pressure to an air-tank-type accumulator.

ORE HOIST AT NORANDA MINES

Fig. 12 shows a hoist designed for Noranda Mines, Ltd., Noranda, Quebec, by Nordberg Manufacturing Company and built at the works of John Bertram and Sons, Ltd., Dundas, Ontario. Principal specifications are given in Table 6.

TABLE 6 PRINCIPAL DATA ON ORE HOIST AT NORANDA MINES, NORANDA, QUEBEC

Drums of rolled-steel plate, number	2
Diameter of each drum, ft	10
Width of each drum, ft	6
Diameter of rope, in	$1^1/_2$
Length of rope, ft	4200
Hoisting speed, fpm	2200
Weight of ore, lb	12000
Weight of skip, lb	10000
Total rope pull, lb	39640
Brakes, two, diameter of each, ft	12

The 1550-hp direct-current motor was made by Canadian Westinghouse Co. and is direct-connected to the hoist shaft and controlled by a Ward-Leonard-type control. The drum shaft is 18 in. in diameter and is supported in bearings 36 in. long. Designed to operate in balance, the torque of the hoist in that instance is 148,200 ft-lb. But it is capable of handling the load unbalanced, at which time the torque becomes 198,200 ft-lb. Note in Fig. 12 the tooth clutch, the steel-plate brake posts, and the Lilly controllers.

HOIST AT INTERNATIONAL NICKEL

Fig. 11 shows a hoist designed for International Nickel Company by Nordberg Manufacturing Company and built at the works of John Bertram and Sons, Ltd., Dundas, Ontario. The hoist shown is installed at the Creighton mine, and is one of three duplicate hoists furnished to this company, while a fourth is now under construction. Principal dimensions and weights are given in Table 5.

TABLE 5 PRINCIPAL DATA ON HOIST AT INTERNATIONAL NICKEL, COPPER CLIFF, ONT.

Drums of rolled-steel plate, number	2
Diameter of each drum, ft	14
Width of each drum, ft	8
Diameter of hoisting rope, in	$1^3/_4$
Length of rope, ft	4200
Hoisting speed, fpm	1500
Weight of ore, lb	12940
Weight of skip, lb	13080
Total rope pull, lb	49120
Brakes, two, diameter of each, ft	14

The 1200-hp direct-current motor was furnished by Canadian Westinghouse Company, Ltd., and drives the hoist through Falk herringbone gears, the ratio being 1 to 11.815. The hoist was designed to operate normally in balance, but can handle

UNDERGROUND ORE HOIST AT DOME MINES

Fig. 13 illustrates a skip hoist built for Dome Mines, Ltd., South Porcupine, Ontario, by Dominion Engineering Company, Ltd. As this hoist was lowered to the 1600-ft level and then transported underground for a distance of almost a mile,

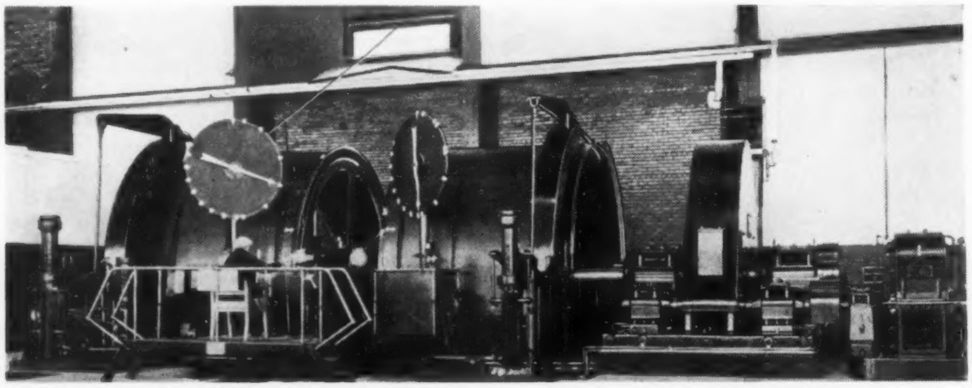


FIG. 11 HOIST AT INTERNATIONAL NICKEL CREIGHTON MINE

the drums were made in sections. The hoist is driven through generated-tooth-herringbone gears. Gear and pinion teeth are lapped, the pinion teeth having been previously hardened. The brakes are of the balanced-parallel-motion type, applied by weights and released by oil. The brake shoes are steel weldings, with removable basswood-block inserts, having quick-release slot bar fixing to the shoes. Each brake has a Lilly controller giving all the usual features of protection.

The clutch-operating mechanisms are interlocked with the brake mechanisms and a possibility of faulty manipulation is eliminated. All the main interlocks are contained in an oil-bath interlock box, a new development in mine-hoist operation, which contains a system of hardened-steel shuffle pawls in horizontal ways, in conjunction with vertical hardened-steel notched bars connected to the operator's levers. The box is located as a removable unit under the operator's platform. Oil pressure is supplied by a self-contained unit comprising a large oil-pressure vessel and dual-motor-driven rotary pumps. A change-over switch is provided so that the operator may alternately use either pump.

COMPRESSED-AIR HOISTS

Fig. 14 shows a hoist built by Canadian Ingersoll-Rand Co. for Bell Asbestos Mines, Thetford Mine, Quebec. A compressed-air hoist was installed because the mine had a good supply of compressed air and did not want to increase the peak load on the electric-supply line. At first the hoist was used for shaft sinking but it is now used to raise ore. The drum on the left-hand side in Fig. 14 has a positive clutch of the sliding-gear type. Reversal is accomplished by link motion. Safety devices include an emergency-stop valve and an emergency brake on the crankshaft. Diameter and stroke of the air pistons are 9 and 8 in., respectively, the maximum pull on one rope is 9000 lb, and the maximum rope speed is 400 fpm.

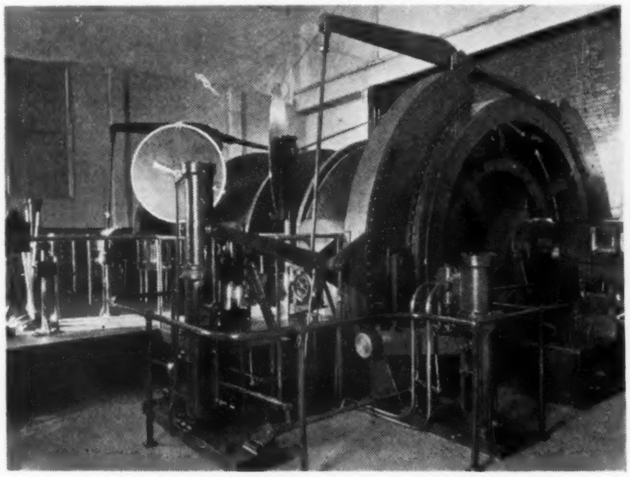


FIG. 12 ORE HOIST AT NORANDA MINES

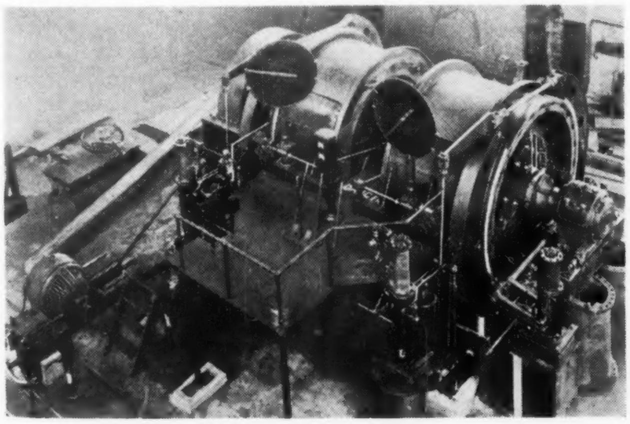


FIG. 13 SKIP HOIST AT DOME MINES

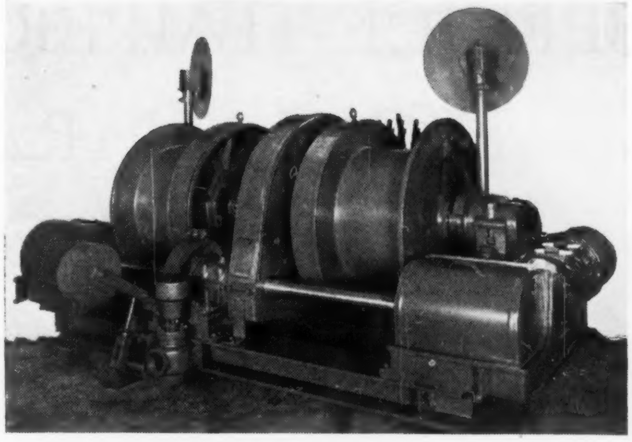


FIG. 14 COMPRESSED-AIR HOIST AT BELL ASBESTOS MINES

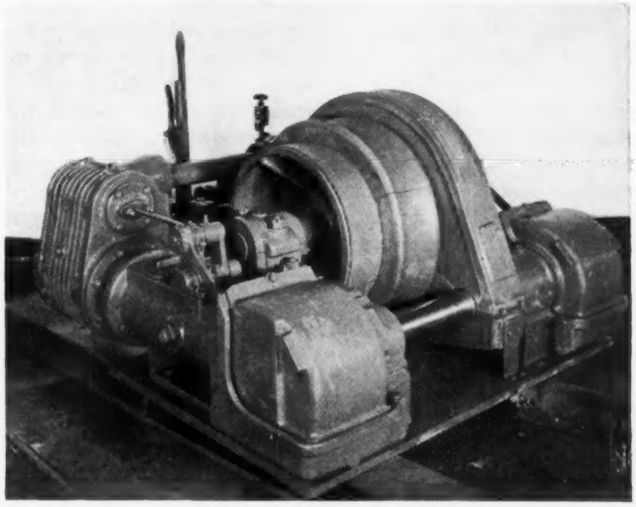


FIG. 15 COMPRESSED-AIR ENDLESS-ROPE HAULAGE ENGINE AT DOMINION COAL MINE

COMPRESSED-AIR ENDLESS-ROPE HAULAGE ENGINE AT DOMINION COAL COMPANY'S MINE, GLACE BAY, N. S.

Fig. 15 shows one of several endless-rope haulage engines built by Canadian Ingersoll-Rand Co. for Dominion Coal Co., Ltd., Glace Bay, Nova Scotia. The specifications of the non-reversing engine are as follows:

Diameter and stroke of air cylinders, in.	8 × 6
Air pressure, lb per sq in.	70
Rope pull, lb	3300
Rope speed, fpm	500

The cylinders have piston valves driven by return cranks.

ACKNOWLEDGMENT

The authors wish to thank Alex J. Nicht, engineer, Canadian Allis-Chalmers, Ltd., the Dominion Engineering Company, Ltd., the Nordberg Manufacturing Co., and others for their wholehearted cooperation in the preparation of this paper.

SERVICE-TEMPERATURE FLOW CHARACTERISTICS *of* THERMOPLASTICS

By W. F. BARTOE

RÖHM & HAAS CO., PHILADELPHIA, PA.

IT IS customary to publish in a table of data of properties of an organic plastic some figures which are called tensile strength, compressive strength, flexural strength, elongation, hardness, modulus of elasticity, and the like. Seldom are these data of any value when considered individually. If one is acquainted with similar data as they apply to other plastics, or if he has available a larger table giving a comparison of these properties, an estimate can be made of the probable performance of the material in question, but at best this estimate will be only a first approximation. This is partly due to the wide differences in methods used by different laboratories in testing different materials. It is recognized that these differences in methods make for real differences in results.

Fortunately for those of us who prepare such data, and more fortunately for those who attempt to use it, considerable effort is being expended in an attempt to unify test methods. Unfortunately, it appears that this end, if and when it is attained, will probably fall short of eliminating all question in making a direct comparison of materials for a given application. It will fall even shorter of giving the engineer, who is designing a new structural application, all of the information necessary to assure the success of his design. It is hoped that future tables of properties will list all of the desired data. At present, it appears that a chart containing these data would have to be extensive and cumbersome. In the meantime the designer and engineer, urged by some definitely desirable property of a material such as specific gravity or transparency or some characteristic such as formability, are proceeding by "cut-and-try" methods. It is the purpose of this paper to point out some of the simpler aspects of two of these "properties" (the so-called tensile and compressive strength) in the hope of promoting thought and experimentation toward simplification of the future problems of structural applications of thermoplastic resins.

EFFECT OF EXTERNAL STRESSES

Stress-bearing members of metal used at temperatures up to about 400 F do not seem to present much of a problem to those who work with them every day. This situation is somewhat changed when service temperatures above, let us say, 1000 F are involved. However, the problems of stress-bearing members of organic plastics used at ordinary room temperature can be likened to those of the use of metals at ten times this temperature. For example, Fig. 1 shows the tensile stress-strain relationships, at various temperatures, of a thermoplastic resin which is usually quoted in physical data tables as having a tensile strength of 7000 to 9000 psi. (The conditions of testing are specified on the curves.) This is obviously a misstatement, since the maximum tensile stress varies almost 4000 psi within the range of ordinary room-temperature changes. Since temperature changes of —20 F to 140 F are not uncommon in human experience, it may be concluded therefore that the original statement of tensile strength was hardly more than the expression of an order of magnitude.

FIG. 1

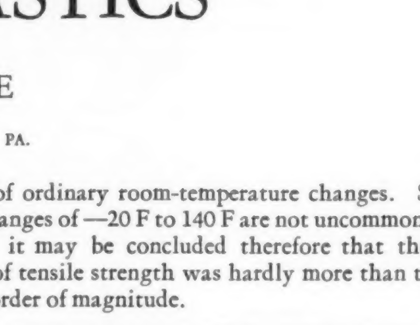


FIG. 2

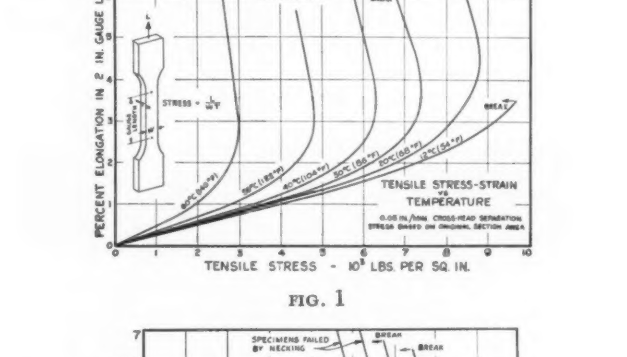


FIG. 3

Contributed by the Process Industries Division for presentation at the Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, of The American Society of Mechanical Engineers.

A second important factor is indicated by the curves of Fig. 2, which shows the different tensile-stress-strain curves obtained by using different time rates of testing. Because it is difficult to make such tensile-stress measurements, compressive-stress tests have been resorted to in extending this survey.

Compressive-strength tests are usually made by squeezing a cube or cylinder of the material between the crossheads of a testing machine while measuring the load required and the relative displacement of the crossheads. The usual testing machine is designed to apply a constant rate of strain and by some balance mechanism to measure the resultant loads. Fig. 3 shows some compressive stress-strain data obtained in this manner for the same organic plastic whose tensile-stress-strain data were shown in Fig. 1. Again it is obvious that the usual "table value" of 11,000 to 13,000 psi fails to represent actual data.

Since the compressive strength of an organic plastic is dependent on the temperature and the rate of straining (other factors such as test-specimen shape and previous history also enter into laboratory evaluation) it would be expected that none of the data presented would be of much value in designing for constant stress externally or internally applied. This is true, and Figs. 4 to 8, inclusive, show to what degree the structural designer must discount the published "table data."

Fig. 4 shows the relation between time of application of a constant load (applied between parallel plates by a lever-and-weight mechanism) and the compressive strain of a $^1/_2$-in. cube of the thermoplastic resin. The first deformation takes place so quickly that it cannot be shown on the curve except as a vertical shift from zero strain to a small (about 2 per cent) flow-starting strain at zero time. From then on the rate of strain, as defined by the slope of the curves shown, tends to decrease with time. This decrease of rate of strain is partially due to a form of work hardening of the thermoplastic and partially to the decrease of the average unit compressive stress resulting from the "barreling-out" of the test specimen. The secondary upward turn of the curve is characteristic of some resins. It is probably due to some sort of breakdown of the structure of the resin. The effect of the change in cross-sectional area has been approximately compensated in the dotted curve by calculating the instantaneous compressive stress at the end of the test and using this stress value to determine a corrected rate of deformation. The remaining curvature indicates the existence of a work-hardening effect in the resin.

The curve of Fig. 4 is for one initial value of compressive stress and one temperature. Other such curves can be drawn for other stress values and other temperatures. Such a family of curves soon becomes complex and difficult to visualize. For the purpose of practical use it is convenient to plot the logarithm of time versus the applied stress at some arbitrary temperature and plastic (gross minus first or elastic) strain value. Fig. 5 shows the details of such a curve for a 10 per cent plastic strain and a temperature of 30 C (86 F). The usefulness of these data can be further extended by plotting a family of curves for different temperatures, such as are shown in Fig. 6.

If we now plot the compressive stress at 10 per cent strain, obtained by compressing at the rate of 0.05 in. per min (from Fig. 3), and the compressive stress which produces a 10 per cent plastic (not completely self-recoverable) deformation in 10,000 min (about 7 days), versus temperature, we obtain the two curves shown in Fig. 7. The curve for sustained compressive stress lies below that for a sustained rate of compressive deformation at every temperature. From this it is obvious that the "table value" of 11,000 to 13,000 psi when used for design-

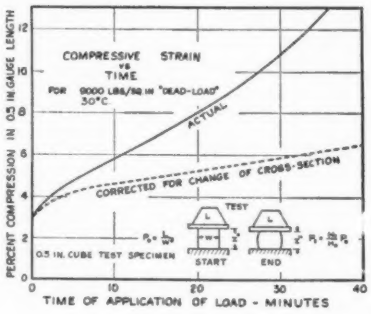


FIG. 4

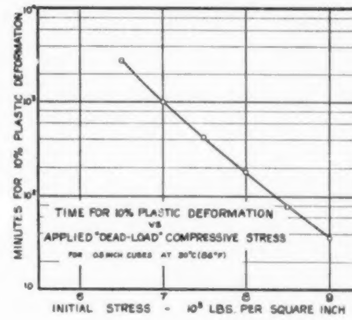


FIG. 5

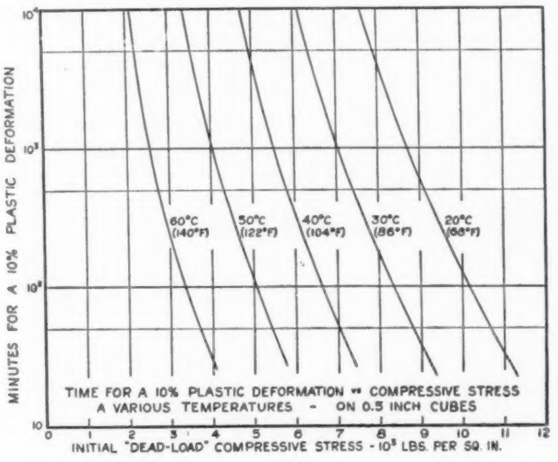


FIG. 6

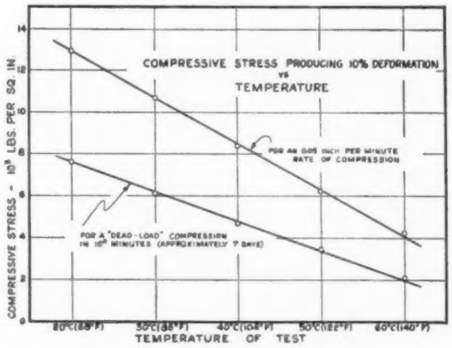


FIG. 7

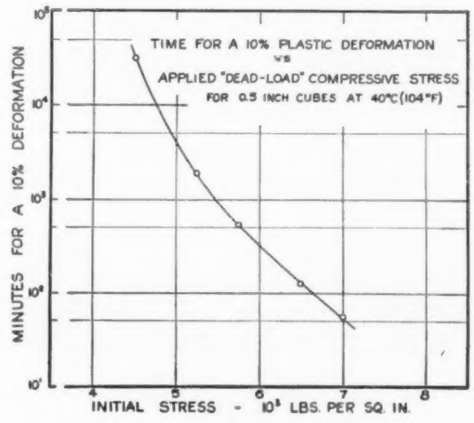


FIG. 8

ing a structural member, may be in error by a factor of as much as 7 within the range of service temperatures.

All of these data have probably created the impression that such materials as these can hold little attraction for use in structural design. This might be true if it were not for the fact that some of the other properties of the material, such as the afore-mentioned low density, transparency, and formability, are desirable in some applications. In addition to this some of the synthetic resins are so homogeneous that when their limitations are known they are pleasing materials to work with.

Fig. 8 shows an extended curve of compressive stress versus the logarithm of time for the methacrylate resin that we have been considering. Such curves are tedious to obtain experimentally but are interesting because they encourage us by their upward turn at the lower stress values. This inflection indicates the existence of a limiting allowable stress which will not produce the specified flow. Other simulated service tests have shown that such a limit does exist. These observations have encouraged an ever-increasing number of uses of this resin as a stress-bearing material. Most of these applications have been in windows for pressure-tight enclosures where the qualities of formability, low unit weight, and optical clarity are desirable. Recognition of such stress-bearing limitations of plastic materials of construction should facilitate and improve these applications.

EFFECT OF INTERNAL STRESSES

Materials are also frequently subjected to the action of stresses which are not obviously existent. Molded thermoplastics are usually subjected to the action of internal stresses. Most of the thermoplastic resins now commonly in use have some elastic property. When these resins are molded, their elastic property, combined with the molding conditions, and their relatively high coefficient of expansion, cause stresses to be

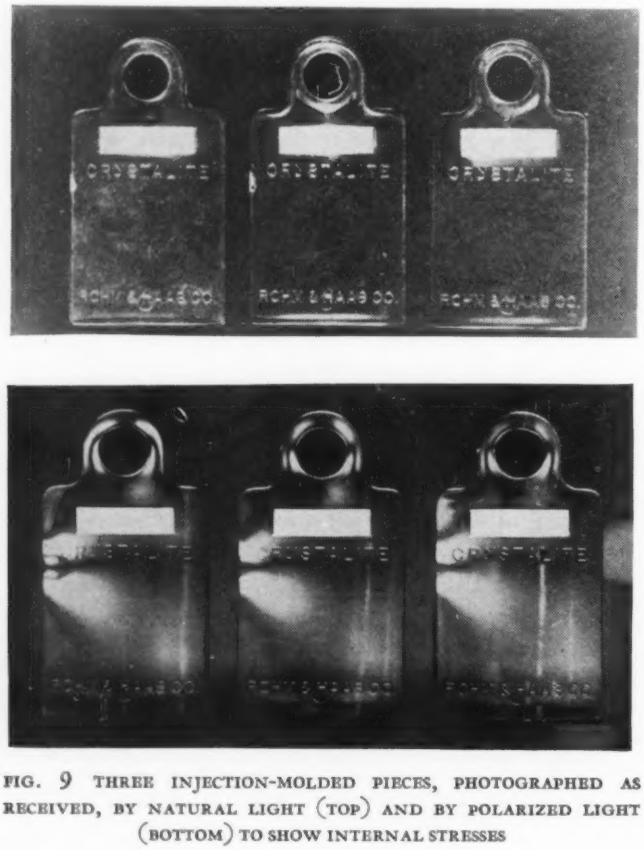


FIG. 9 THREE INJECTION-MOLDED PIECES, PHOTOGRAPHED AS RECEIVED, BY NATURAL LIGHT (TOP) AND BY POLARIZED LIGHT (BOTTOM) TO SHOW INTERNAL STRESSES

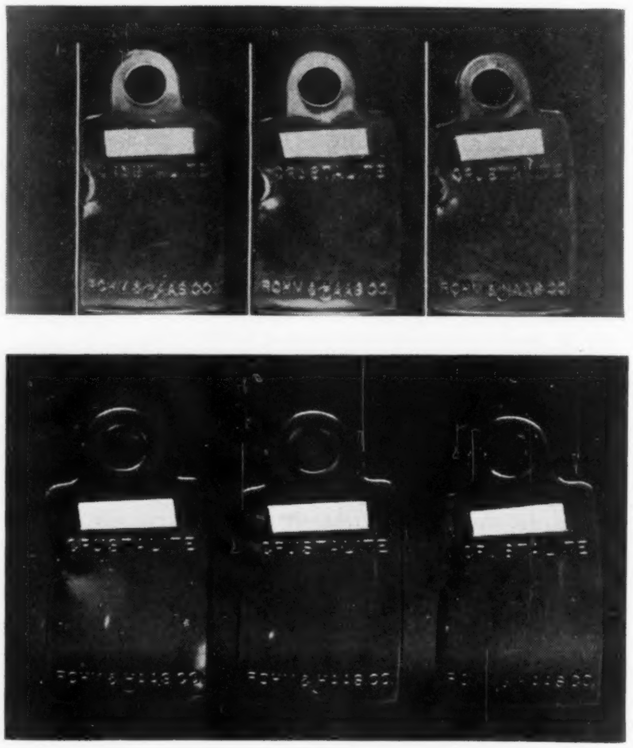


FIG. 10 THREE INJECTION-MOLDED PIECES OF FIG. 9 AFTER HEATING FOR ABOUT 100 MIN AT 170 F, PHOTOGRAPHED BY NATURAL LIGHT (TOP) AND BY POLARIZED LIGHT (BOTTOM) TO SHOW DISAPPEARANCE OF INTERNAL STRESSES AS A RESULT OF HEATING

set up within the material. This happens in any of the methods of molding but most particularly in so-called "injection" molding. At the top of Fig. 9 are shown three injection-molded pieces. At the bottom these same pieces are shown as observed in polarized and analyzed light. The presence of internal stresses is revealed because the material is photoelastically stress-sensitive. The stress concentration around the injection gate will cause a permanent deformation at this spot if the piece is heated to the temperature at which these stresses equal or exceed the flow resistance of the material. At the top of Fig. 10 these same pieces are shown as they appear in natural light after they have been heated for about 100 min at 170 F, while in the view at the bottom the use of polarized light has revealed the fact that most of the internal stresses have been relieved by this treatment.

A measurement of the recovery deformation could be combined with data on the constant stress-strain characteristics of the material to determine the actual stresses formerly existent in the material. It is not at all unusual to observe stresses which are capable of causing dimensional deformations of 10 per cent within the service temperature range. A somewhat exaggerated case of this sort was noted in a cylinder 1 in. in diameter and 1 in. long which was compressed to about 84 per cent of its original height by a stress of 12,000 psi at 20 C (68 F). On being heated to 100 C (212 F) this piece recovered to about 93 per cent of its original height. Obviously, this might void the piece for its intended use. Such difficulties can often be avoided by taking into account the possible effects of such stresses and devising changes in the molding technique which will minimize their formation.

It is hoped that this discussion will encourage further laboratory and practical experimentation with thermoplastic resins with the view of obtaining more complete data of real value to the plastics engineer and designer.

DEFINING EQUITABLE LIMITS *of* DUST EMISSION *From* STACKS

By P. H. HARDIE

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

MAN'S discovery and use of coal as a source of energy has done much to advance our present civilization, but it has unavoidably been accompanied by other conditions which are annoying and, to a small degree, harmful. Among them is the dust which is continually being discharged into the atmosphere from all solid-fuel-burning equipment whether large or small. Engineers are not unmindful of the need for the improvement of this condition. Much time and money have been applied to the solution of the problem with the result that remarkable progress has been made in the last ten years. That the future will bring even greater strides in this direction, we have every reason to expect.

Although this paper deals mainly with the problem of dust emission from central and industrial plants, it should be recognized that some form of control must be extended to the small coal consumers if we wish to attain considerably higher freedom from dust in the air. Surveys both in this country and in England have shown that the multitude of small users of solid fuel are more responsible for air pollution than the few large consumers.

Some limit to the amount of flue dust discharged into the atmosphere is a necessity. It is only when we try to decide what the limit should be that disagreements arise. What is reasonably possible in the way of flue-dust elimination with commercial equipment now available for this purpose? There is no exact mathematical answer to this question. Allowable limits of dust emission are mainly a matter of definition. If they are to be equitable limits they should be based upon consideration of all the factors involved. Let us then review the more important factors that should be considered.

IMPORTANT FACTORS TO BE CONSIDERED

First of all, the location of the plant is a principal factor which should influence the allowable limits of dust emission. Within a radius of one to five miles, depending on the height of the stack, size of the dust particles, and other factors, some annoyance will probably be caused at times by the dust discharged into the atmosphere. The dust escaping from a stack near a residential or business area undoubtedly causes more complaints than the same amount in a rural or purely manufacturing area.

The size of dust particles is an important factor in determining the annoyance they cause. Large-size particles are almost certain to bring immediate complaint. Particles that are individually too small to be seen with the unaided eye remain in suspension for long periods of time and are rarely considered as a source of annoyance except in the case when they are black and in mass appear as smoke. Probably their chief nuisance lies in the fact that they reduce the transmission of sunlight, especially in the ultraviolet part of the spectrum.

Because less annoyance is caused by the small particles, there is a movement, which started in Europe, to define the "nuisance range" for flue dust as those particles larger than 20 microns in mean diameter. The medical profession and health authorities will probably object to this definition and urge a lower limit. There are good arguments on both sides.

The blackness of the dust particles is another factor to be considered. Every effort should be made to foster those combustion conditions which decrease the carbon content of the flue dust. Usually the pulverized-fuel-fired plants have an advantage when compared with the stoker-fired plants in this respect.

Let us consider next the height of the stack. We have been discussing the dust concentration in the escaping flue gas, when what we are really interested in is the concentration of the deposited and suspended dust resulting from this discharge. Although the total quantity of dust discharged is virtually unaffected by the height of the stack, the height materially governs the area over which the dust is distributed. Another advantage obtained from high stacks is that much of the dust may be carried beyond the point where it can cause a nuisance before it is deposited. Therefore, to be consistent we should have a higher allowable limit for dust emitted from high stacks than from low stacks.

Consideration should be given to the ash content of the coal in normal use in the geographical area before arriving at any limits for dust emission. For pulverized-fuel-fired units especially, the quantity of dust leaving the furnace is roughly proportional to the ash content of the fuel. Virtually all types of dust-separating apparatus have approximately constant efficiency irrespective of the dust concentration of the gas entering them, all other factors remaining constant. Therefore, the higher the ash content of the coal used the more difficult it is to meet a given limit of dust emission.

The quantity of dust carried with the flue gases from the boiler to the dust separator is also dependent upon such factors as the type of firing, type of furnace, and burning rate. For high ratings, especially with some types of coal, the carbon content of the dust may be so high that the quantity of dust entering the separator exceeds the aggregate ash in the coal burned. Under more favorable conditions the quantity of flue dust may be in the order of one half the aggregate ash in the coal burned. In this connection it is of interest to note that slightly less ash results from the combustion of coal in a commercial furnace than is shown by the standard laboratory analysis. Failure to take this into consideration has been known to result in incorrect conclusions as to dust-separator efficiencies when the quantity of dust entering the separator was computed from the weight of coal burned and its ash content.

THE QUESTION OF COLLECTOR EFFICIENCY

One could hardly present a paper of this type without discussing efficiency of collection obtained with commercial-type dust separators. Collector efficiency is probably the biggest single factor which should be considered in defining allowable limits of dust emission and it is also the one most open to debate. Extravagant claims have been made by some manufac-

Contributed by the Fuels Division for presentation at the Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

turers of dust-separating apparatus in the past. A scarcity of complete test data on full-size installations is one of the causes of this condition. Knowledge of how to obtain reliable field data has not been widespread. With an A.S.M.E. Power Test Code in tentative form and soon to be made a standard practice for the Society, more test data which can be considered reliable should soon be available.

Eighty-five per cent over-all efficiency of separation is still a value obtained by but few installations day in and day out. It is true, guarantees of 90 per cent and even better have been made and met on acceptance tests, but in everyday operation the acceptance-test value is maintained only in those plants which take exceptional care in the operation and maintenance of their dust-separating equipment. To assure optimum performance, it is also necessary to have trained personnel and adequate test instruments for periodic checks on the performance of the dust-separating equipment.

It seems reasonable to assume that in the average plant the dust separators operate at about 5 per cent below their acceptance-test efficiencies. This may seem like a relatively small difference when dealing with dust, but suppose the specified limit of dust emission can be met with a 90 per cent separator and a separator of this efficiency is purchased which meets its guarantee on the acceptance test. If in actual operation, however, it averaged only 85 per cent, the specified limits of dust emission would be exceeded by 50 per cent, a value which would surely be considered excessive.

PRESENT BASIS FOR LIMITS EXAMINED

The application of the factors discussed to the problem at hand leads to an examination of existing tentative limits. There is a tendency in this country to adopt the same limits of emission as have been established in England. This would seem to presuppose that conditions are similar in the two countries and that the English have found their limits workable. Both suppositions are open to debate.

Such flue-dust critera as have been formulated have followed the practice set up by health authorities for making dust counts by expressing the limits in terms of the amount of dust per unit volume of gas. The dust concentration, expressed in terms of the quantity of flue gas, is admittedly convenient since it requires no knowledge of what has happened before the point of measurement, but it has the effect of penalizing the better operated plants. The smaller the percentage of excess air supplied for combustion and the tighter the flues, the higher the dust concentration, all other factors remaining the same.

Would it not be better to base our permissible limits on the weight of fuel burned? We could accomplish this result and still keep dust concentration as our unit if the volume of gas leaving the stack were corrected to that which would exist at a fixed temperature and a fixed CO_2 content. The change in the quantity of air supplied to produce any given change in CO_2 of the escaping gases is easily computed. The small extra cost for measuring the CO_2 should not make this correction prohibitive.

If it were possible to determine the average flue-dust emission (a method for doing this will be discussed subsequently), would it not be better to use the average for each 24 hours than to specify a maximum which should never be exceeded? A plant which never exceeds the permissible limit but always operates close to it is obviously not as good as another plant which sometimes exceeds the limit but has a lower average value.

CONTINUOUS CHECK ON DUST EMISSION SUGGESTED

This discussion prompts the author to suggest the following procedure, namely, that a single sampler be operated continuously in each stack at a predetermined position where mean values are obtained and that the sampled dust be removed and weighed either every watch or once a day. If such measurements were incorporated as part of the regular station records, it would be easy to detect impairment in dust-separating efficiency. All too often dust separators are neglected once they have been installed and the acceptance test made. The expense of a complete test at frequent intervals is prohibitive. Then it seems imperative to have a continuous method of checking dust emission even though such reading would not approach the same degree of accuracy obtained with a complete survey of the stack.

With pulverized-fuel-fired plants the dust particles are small and therefore they mix more thoroughly with the gases. This means the dust concentration is more nearly uniform and that the position of the sampling tube in the stack has less effect upon the results obtained. The same condition will exist in stoker-fired plants equipped with dust separators which remove virtually all of the dust particles larger than 44 microns. Plants not equipped with dust separators that remove all of the larger particles will find it more difficult to obtain an average value of dust concentration with a single sampling tube.

In order to install a continuous sampler that will function properly, certain requirements should be adhered to. The dust-separating device in the sampling line should be located at the point where the sampling tube emerges from the stack even though it is necessary to locate the sampling tube some distance above the roof. If this should prove impossible it is necessary either to steam-jacket the line or run it inside of the stack; even so, a long line between the sampling point and the separating device is not conducive to reliable results.

The dust-separating device should be a small cyclone of high efficiency (i.e., 97 to 98 per cent) or a cloth filter bag. With a cyclone the problem of controlling the sampling rate is reduced since the resistance for a given gas-flow rate does not change. By connecting the discharge line from the dust separator to the inlet side of the induced-draft fans a change in sampling rate will accompany each change in load. This will tend to maintain roughly the required sampling rate at all loads once the correct sampling rate has been adjusted for an average load. If found necessary, minor adjustments of the sampling rate could be made by an attendant stationed near this part of the plant.

A sampling nozzle of the "null" type with pressure connections extended to the point where the control valve is located is virtually a necessity. As a measure of the total volume of gas sampled, a gas meter of the integrating type will be found to be most suitable.

Combustion Space, Setting Height, Smoke

TO throw some light on the question of the correct combustion space and setting height that should be allowed in boilers fired by underfeed stokers using bituminous coal, a field survey has been conducted by the engineers of the Battelle Memorial Institute for stoker, coal, and boiler interests. The report presents data obtained in a factual survey of 102 installations and an experimental survey of 22 installations in various cities including both high- and low-volatile coals and cast-iron and steel boilers fired with stokers burning 20 to 900 lb of coal per hr. No relation was found between the rate of heat liberation per unit of furnace volume and the amount of smoke emitted but a trend toward decreased smoke with increase in setting height was found for stokers feeding more than 400 lb of coal per hr. Paper presented by R. C. Cross, R. A. Sherman, and H. N. Ostborg, at 33rd Annual Convention, Smoke Prevention Association, Milwaukee, Wis., June 13–16, 1939.

MACHINE DESIGN *and* MOTION ECONOMY

Building Motion Economy Into Machine Tools—Some Examples and Suggestions

By O. W. HABEL[1] and G. G. KEARFUL[2]

EARLY in 1939 the Saginaw Steering Gear Division had correspondence with Mr. Tel Berna of the National Machine Tool Builders' Association in regard to some ideas in applying the principles of motion economy to the design of machine tools. Mr. Berna apparently discussed this correspondence with some members of The American Society of Mechanical Engineers, and, as a result, we were invited to present our ideas before this group. We make this explanation because we do not wish to leave the impression that we presume to be authorities on building machinery. We are only users of machinery, but we believe that our suggestions may result in machinery which will better suit our requirements.

The machine-tool industry has done a remarkable job in recent years in building machines which give us the speeds, feeds, and accuracy we now enjoy. Many special machines have been built, the performances of which have been amazing, and their use has made extraordinary economies possible. In our experience the machine-tool men will give us anything we want in the line of efficient machinery if we tell them what we want, pay the price, and wait for them to design and build it.

However, in our opinion not enough thought and attention have been given to the efficient use of the man who operates the machine.

In our opinion the most important principles of motion economy as advanced by the Gilbreths, Segur, Mogensen, and others, are:

1 Eliminate all *unnecessary* movements of the workman
2 Shorten and simplify all *necessary* movements
3 Balance the work
4 Minimize use of the eyes
5 Eliminate the use of the hands as holding devices.

Some ways in which these principles may be applied are as follows:

1 To eliminate *unnecessary* movements:
   (*a*) Replace hand movement by mechanical movement
   (*b*) Replace hand movement by foot or knee movement
   (*c*) Eliminate the passing of work, tools, or controls from one hand to the other
   (*d*) Combine movements by providing controls with multiple functions
   (*e*) Provide for drop discharge of finished work.

2 To shorten and simplify *necessary* movements:
   (*a*) Keep movements within normal work space
   (*b*) Eliminate barriers
   (*c*) Arrange for getting and disposing of material in adjacent locations.

3 To balance the work:
   (*a*) Eliminate wait of one hand
   (*b*) Keep both hands busy with *useful* work.

4 To minimize use of eyes:
   (*a*) Eliminate hard-to-find controls (avoid small buttons)
   (*b*) Aid positioning by use of bellmouths and bullet noses
   (*c*) Keep necessary use of eyes within minimum area.

5 To eliminate use of hands for holding:
   (*a*) Eliminate use of hands for holding machine part
   (*b*) Eliminate use of hands for holding work.

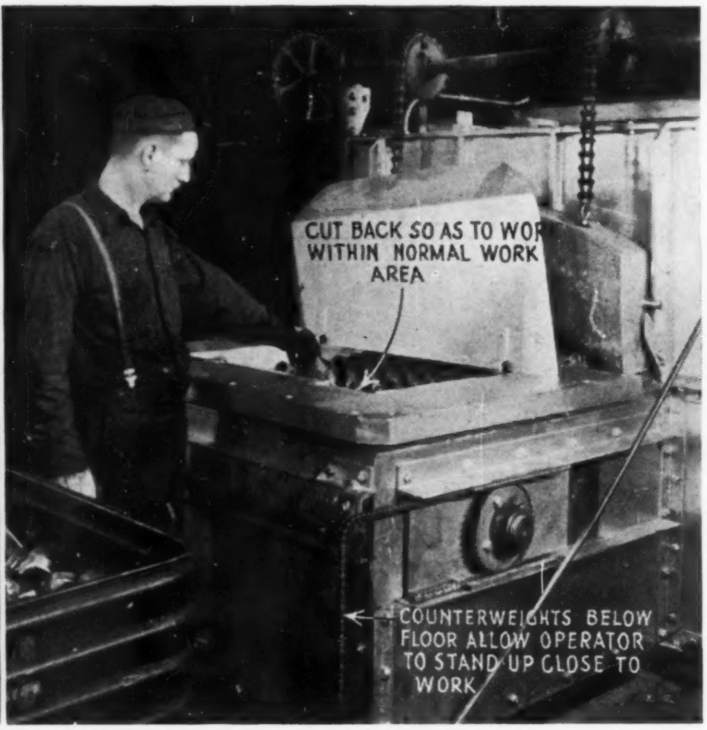
For several years we have been applying with excellent results these principles to our productive operations and the proposed application of them is now definitely borne in mind when designing jigs, fixtures, dies, benches, and special equipment made in our own plant. However, in the purchase of machine tools we find in many cases that these principles have not been considered in the fundamental design and that we either cannot get what we want or must pay extra for them.

Our own experience with our tool designers and toolmakers who were given motion-economy training leads us to believe that the machine-tool industry with properly trained designers could furnish us at no extra cost machines with these motion-saving principles built into them. With their designers thoroughly grounded in the principles of motion economy, the industry would be able to design and build the more or less standard machines so as to utilize the machine operator's time much more efficiently. In cases where special machines are justified, the machine-tool builder would come to us better qualified to suggest economical methods of doing the job with more efficient use of the machine operator's time and, perhaps, fewer special features in the machine, thus achieving the desired economy at *less* cost.

As a concrete case, in our plant, we had a rethreading operation on a ball stud for which we used a standard two-spindle threading machine which cost $1356. This machine produced 600 parts per hour. Later, due to increase in production, we needed another machine. At this time our master mechanic, who, with his more highly skilled toolmakers had just completed a course in motion economy, asked to be allowed to build the additional machine applying these principles. His machine cost $786 and produces 1100 parts per hour with, we believe, less effort on the part of the operator. Thus, with an investment of about one half as much money we have a machine that does almost twice as much work per man-hour.

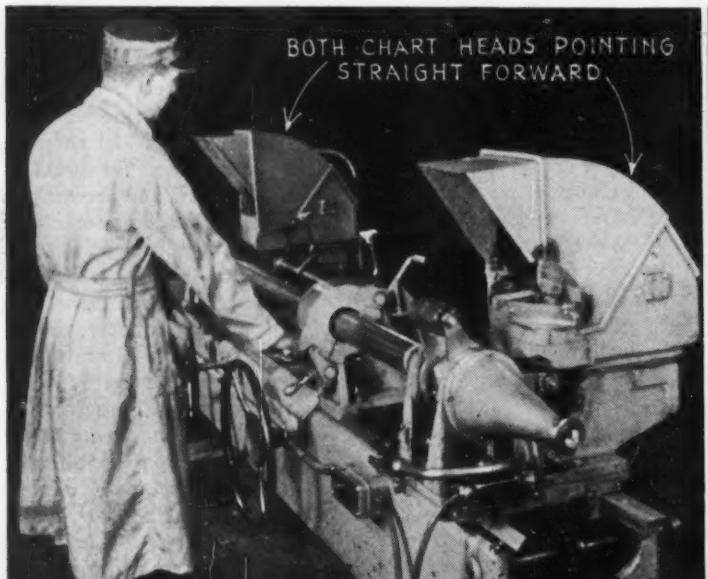
The illustrations on the next two pages demonstrate some ideas of good and bad motion-economy design in machine tools.

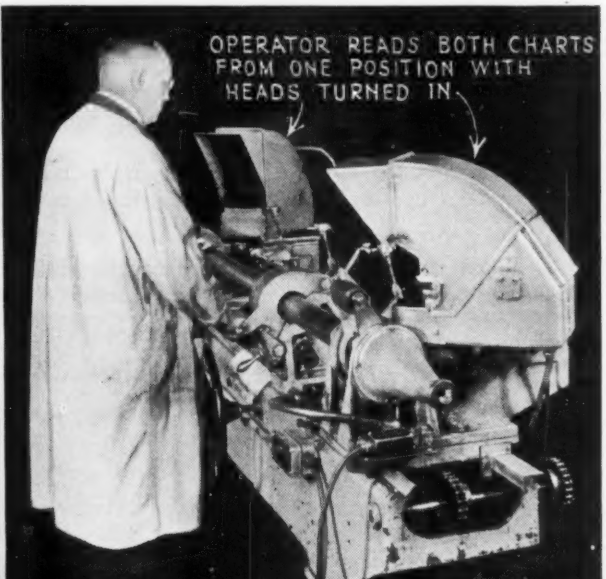
[1] Factory Manager, Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Mich.
[2] Methods Engineer, Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Mich.
Contributed by the Machine Shop Practice Division for presentation at the Annual Meeting, Philadelphia, Pa., Dec. 4-8, 1939, of The American Society of Mechanical Engineers.



HOW A MODERN FURNACE WAS REBUILT WITH THE OPERATOR IN MIND

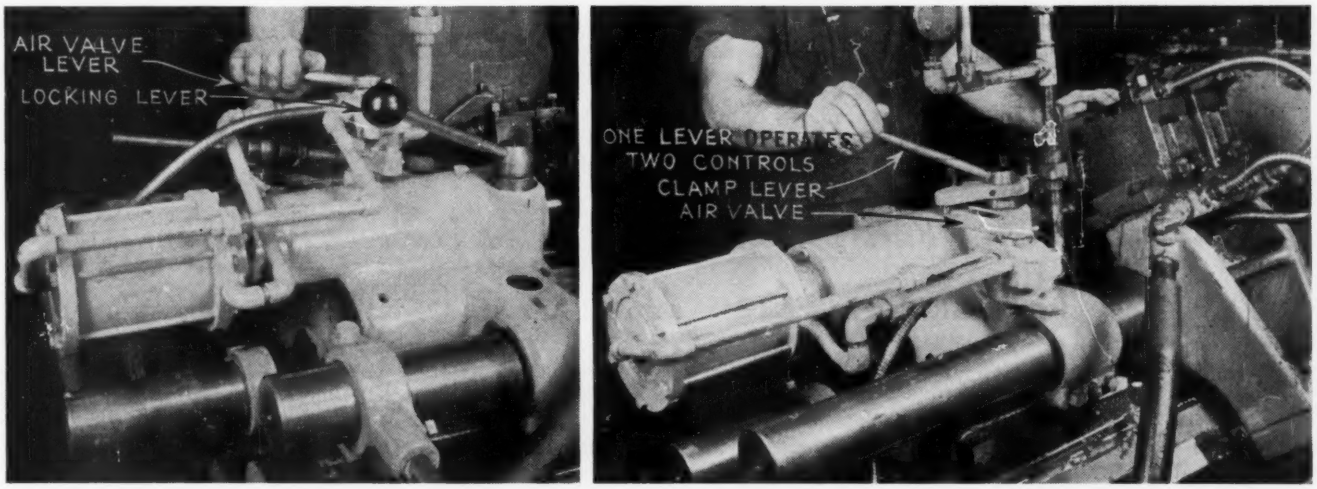
(Two new modern furnaces as built (*left*) required two superlong-armed men to keep the conveyer belts loaded. The furnaces were rebuilt (*right*). Counterweights were placed below the floor. Conveyer belts were extended and tables cut back. These changes made it possible for one man to operate both furnaces.)





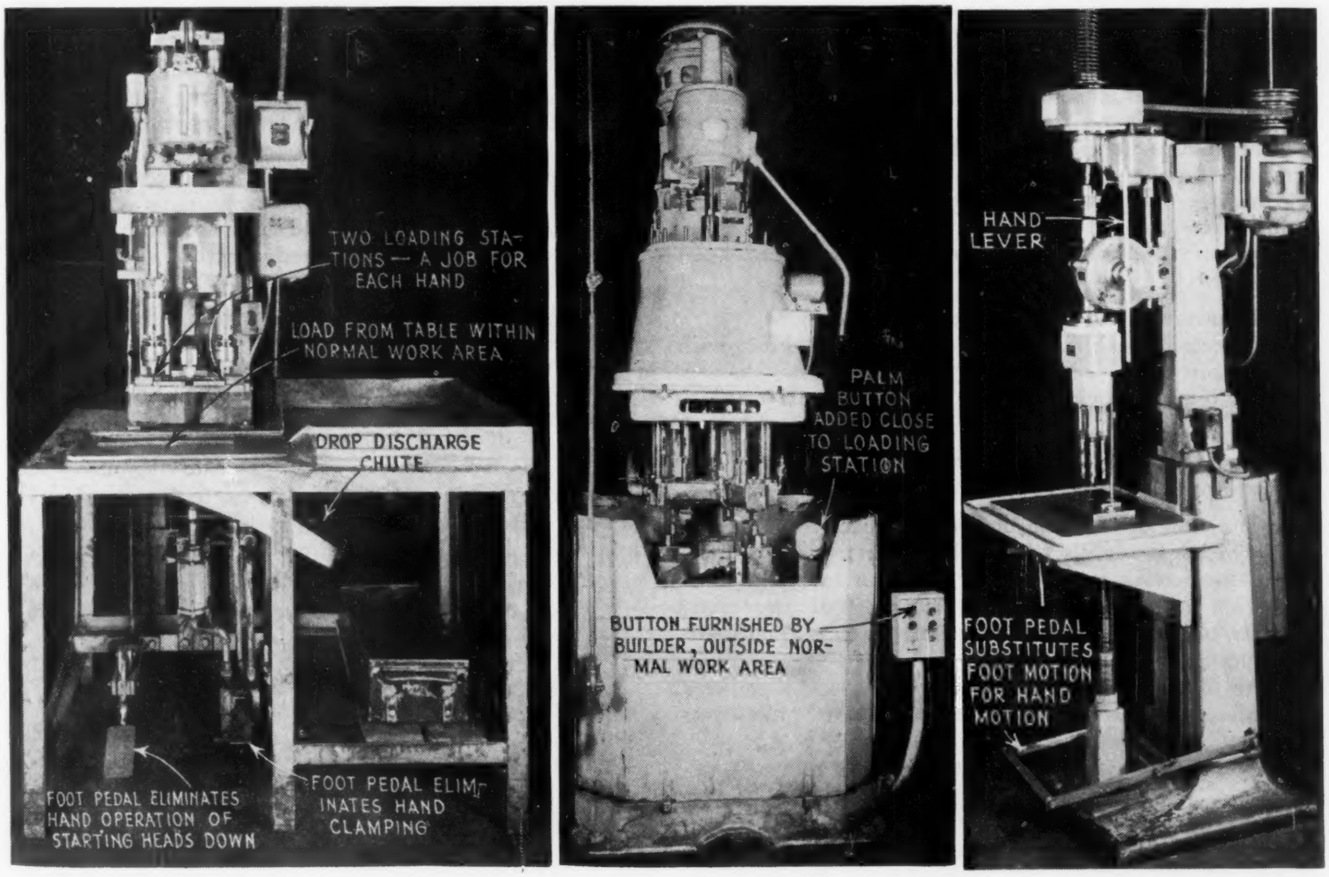
THE OPERATOR NOW USES HIS HEAD INSTEAD OF HIS FEET

(This dynamic balancing machine was delivered with chart heads at each end pointing straight forward (*left*). This made it necessary for the operator to walk about eight feet from one end of the machine to the other each time he checked the balance of the part. A simple change (*right*) made it possible to turn the chart heads in at an angle so that a man standing at the center of the machine can observe both charts without taking a step.)



ONE CONTROL WAS DESIGNED TO DO THE WORK OF TWO

(Air-operated lathe tail center (*left*) with two separate controls, one an air valve, which advances and returns the center, and the other a clamp. These have been combined in the illustration at the right. Air-operated lathe tail center with only one hand lever (*right*) which operates both clamp and air valve. Note the fork on the air valve which is picked up by the cam on the locking lever. This combination results in a direct saving by reducing the "down" time of the machine between cycles.)



ATTENTION TO SIMPLE DETAILS MAKES A BETTER MACHINE

(*Left:* Rethreading machine designed and built by men schooled in motion economy, which cost only one half as much and turns out twice as much production as a standard machine. The operator sits comfortably at his work. Each hand picks up a blank from the convenient table and loads the two-station fixture. Pressure of the right foot on the air valve operates the clamping mechanism. Pressure of the left foot brings the die heads down. When the operation is completed, pressure of the right foot causes threaded parts to drop into the discharge chute and out into a tote pan. *Center:* One of the most common faults with machines as received from the builder is that they are equipped with small, hard-to-find starting buttons. On the machine shown in the center the operator had to lean back, twist his body, and "eye-direct" his hand to the button each time the machine went through its cycle. This can be remedied by installing a palm button close to the loading station which will result in a direct saving by reducing the "down" time of the machine between cycles. *Right:* The addition of a simple foot pedal freed both hands on this countersinking operation and resulted in a 47 per cent increase in production.)

GRADUATE WORK *in* ENGINEERING

Development of a Part-Time Program at the University of Tennessee

By CHARLES E. FERRIS[1] and RICHARD O. NIEHOFF[2]

IN THE PRINCIPAL engineering offices, located about one mile from the main campus of the University of Tennessee at Knoxville, approximately 500 professional and subprofessional engineers are employed by the Tennessee Valley Authority. In addition there are at least 100 other engineers in local industries located within reach of the University who are eligible for participation in a part-time graduate-training program. Although this article is primarily concerned with the engineering employees of the Tennessee Valley Authority, the entire group of practicing engineers of the Knoxville area is considered in the educational plans which are being made for the development of a part-time graduate program.

DEVELOPMENT OF THE PROGRAM

The in-service training program for engineers is guided by objectives and policies which apply to all phases of the Authority's educational and training program for its employees. This program is administered by the training division of the personnel department. The principal objectives and policies which are pertinent for an understanding of this description are as follows:

Aims and Objectives. The program is designed to assist employees:

1 In increasing their efficiency on their present jobs.

2 To become qualified for more responsible positions with the Authority.

3 To continue their technical and professional development.

Policies. The policies established for the conduct of the program are as follows:

1 The training division has no preconceived "curriculum" which it has developed and which it attempts to promote among engineering employees. It functions rather as a coordinating agency through which individual employees, groups of employees, and the training committee can find assistance in carrying out their educational plans.

2 All participation is voluntary.

3 All fees for tuition and supplies are paid by the employees who enroll in the classes.

4 All classes are given on the employees' own time.

5 Employees who have attended at least half of the sessions of any of the engineering classes are given the option of having a training-participation report filed as a part of their personnel record. The report includes a description of the course content, method of conducting the course, extent of participation of the employee, and an evaluation of his work.

BEGINNINGS AT NORRIS

The training program for engineers began shortly after the creation of the Authority, during the construction of Norris Dam in 1934-1935. At that time, approximately 70 employees were enrolled in classes of an undergraduate grade which were offered in cooperation with the University of Tennessee, Extension Division. As the Authority's staff of engineers increased and headquarters were established in Knoxville, several of the classes were repeated there, in addition to several informal noncredit seminars, which were not a part of the cooperative plan with the University of Tennessee.

PROGRAM FOR 1936-1937

Early in the fall of 1936, individual employees and groups of employees began to make their interest in educational activities known to the training division of the Authority. The administrative officers and faculty members of the University of Tennessee were approached concerning the possibilities of cooperation in the offering of graduate classes to the Authority's employees. As a result of these explorations and the announcement of the possibilities to all employees, 101 enrollments were made in concrete structures, water-power engineering, transmission-line theory, and advanced mechanics. All of the courses were offered for graduate credit and taught by qualified professors of the University. Extra compensation was given by the University to these professors for their additional teaching. Class sessions were held both on the campus of the University and in the offices of the Authority. The work was administered by the Extension Division of the University.

Throughout the year, numerous employees raised questions about the residence and accrediting restrictions which were then in force under the rules of the graduate committee. On two separate occasions, this committee saw fit to act on requests for a more liberal interpretation or revision of their rules to fit the growing demands for the accreditation of a program which would permit those interested to pursue work toward a master's degree.

PROGRAM FOR 1937-1938

The enthusiasm and sincerity, displayed by these adult students during the first year of the program, stimulated confidence in the developing project. During the 1937-1938 academic year, another group of graduate courses was offered which attracted 100 different employees for a total of 144 enrollments.

Three of the courses were given by officials of the TVA whose qualifications to teach graduate work met the standards set by the University. The addition of these three special instructors increased the breadth of the courses offered. They also added to the classes which were fully accredited for residence work.

At the end of the 1937-1938 year, it was obvious that the program would either be curtailed or some changes would need to be made in the regulations governing graduate work because several of the part-time students had exhausted the number of courses which could be taken for graduate credit under the then existing rules. In addition, it became more apparent to

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[2] Supervisor of In-Service Training, Tennessee Valley Authority, Knoxville, Tenn.

all concerned that the Authority's engineers were seriously interested in the professional development which could be gained through additional academic preparation. This fact stimulated representatives of both the University and the Authority to find some satisfactory answer to the problems of administration which were developing.

During the spring of 1938, the graduate committee of the University, upon recommendation of the faculty of the College of Engineering, considered a comprehensive plan which dealt with all phases of a project to integrate the program for part-time engineering students with the program for full-time graduate students. After considerable discussion the following plan which is now in force emerged:

1 All work is given as part of the regular offering of the College of Engineering and is administered by the regular academic officers of the University (in contrast to the previous administration by the Extension Division).

2 All classes are scheduled at 5 p.m., on Saturday mornings, or in the evenings and are held on the campus of the University.

3 Wherever possible, graduate work for the full-time graduate students and the part-time graduate students is offered in the same classes, thereby reducing the teaching load, eliminating duplicate instruction, and improving its quality. This latter value is aided in part by having a slightly larger class, sufficient to be stimulating both to the instructor and to the students.

4 All of the work is fully accredited for residence requirements.

5 Part-time students are not permitted to earn more than six hours' credit each quarter.

6 TVA engineers, interested in and capable of giving graduate work, continue to be used as instructors on the same basis of selection as regular members of the graduate faculty.

PROGRAM FOR 1938-1939

The principles of the plan for a closer integration of the graduate program have had one full year of testing. The results of the year's enrollments appear to bear out the soundness of the plan. One hundred and thirty-five enrollments were made in 16 courses,[3] of which 7 were taught by TVA officials. The greater flexibility of the administrative plan has resulted in the continued service of those engineers who want an occasional course to keep abreast of recent developments in engineering, and also those engineers who wish to take sufficient work to earn a master's degree. There are approximately 25 engineers who have taken at least a third of the total number of necessary courses for the master's degree. A number of the men are expected to finish the requirements during the current year.

PARTICIPANTS IN THE 1937-1938 COURSES

Of greater interest perhaps than the administrative considerations and educational procedures thus far indicated are the data on the actual participants in the program. The students, after all, limit the quality of work which can be achieved, determine in a large measure the difficulty of the work assigned, and in other ways form a principal consideration in the analysis and description of any educational program.

AGES OF PARTICIPANTS

Most of the part-time students are young engineers. Seventy-five per cent of them have been graduated from college within a period of approximately 12 years (three student generations). From all indications of the analysis made by the Committee on Professional Training of the Engineers' Council for Professional Development, this is the crucial period in the professional life of the engineer. This is the period after graduation when the "future engineer who, as a student, has enjoyed a congenial environment with its prescribed lessons is likely to find the school of experience a hard one. He is apt to lose his bearings in a sort of no man's land."[4] The curve of an engineer's development, devised by this committee, shows horizontal progress for a period after graduation from college.

In other reports of this Council's deliberations on the professional development of engineers, a set of principles is worked out which indicates the proper age for the certification of young engineers to be approximately 25 to 30 years. The taking of advanced courses in technical subjects as well as general development and progress in responsible engineering work are considered essential preparation for a qualifying examination which leads to certification as a professional engineer. Fifty per cent of the participants in the graduate program are in the age classifications thought of as crucial by this committee and are apparently on the road to meeting some of the qualifications for consideration as professional engineers.

Perhaps it is just as significant that the other 50 per cent of the participants are over the age classification thought to be proper for certification. Furthermore, half of this group are more mature engineers, 36 years of age and over, who are apparently finding a return to organized study helpful in maintaining contact with current developments. In the Engineering Council's zeal for the development of devices to focus attention on the young engineers, perhaps some opportunity has been overlooked in consideration of the educational needs of the older engineer as well. Apparently, the needs of all age groups can be fairly well met in classes which focus attention on technical developments regardless of the age of the enrollees.

HIGHEST EDUCATIONAL ATTAINMENT

The participants in the training program for engineers as well as the total group of engineers are essentially college-trained. Only 12 per cent of the participants are without a college degree or degrees, and only 27 per cent of the total engineering staff, which includes the subprofessional classifications, have not earned academic degrees. In fact, there are more participants who have master's degrees than there are participants who have no degrees at all.

The backgrounds of training for the members of the staff have been secured in many of the major educational institutions in all parts of the country. The high level of training of the participants, as well as the cosmopolitan character of the group, offers an opportunity as well as a challenge to the faculty members who are engaged in the teaching. It is apparent from the analysis of the educational qualifications that there is a large group of potential students for whom and with whom a strong graduate program can be planned. A large percentage of the total group has demonstrated its interest, but there remains a large number which offers a stimulus for further development.

In terms of the minimum definition of an engineer adopted by the Engineers' Council for Professional Development, most members of the Authority's staff meet the educational requirements necessary for certification.

SALARY GRADES OF GRADUATE STUDENTS

By far the largest percentage of part-time graduate students are in the lower salary brackets. This is to be expected and

[3] Statically Indeterminate Structures I and II; Administration of Engineering Projects I and II; Engineering Valuation; Advanced Mechanics I, II, and III; Waterworks Engineering; Transmission-Line Theory; Electrical Power Circuits; Hydraulic Jump and Backwater Curves; Hydraulics of Flood Control; Hydraulic-Engineering Design; Chemical-Engineering Economics I and II.

[4] Fourth Annual Report of the Engineers' Council for Professional Development, New York, N. Y., October, 1936, p. 6.

parallels the fact that the greatest number of participants are in the younger age classifications. Almost 25 per cent of the participating group are in the salary grades above $3000, however, which indicates that training is not only pertinent and attractive to the younger men but also to the older and better-paid. Apparently neither the higher salaries nor the advancing years (which usually correlate very highly) deter engineers who wish to keep abreast of the times by enrolling in post-graduate courses.

REASONS GIVEN FOR TAKING COURSES

The 69 returns on a questionnaire addressed to the 100 participants in the graduate program, which are summarized in Table 1,

TABLE 1 REASONS GIVEN BY PARTICIPANTS IN THE PROGRAM FOR TAKING COURSES

Reason	Number	Percentage
Information only	31	19
Credit toward advanced degree	40[a]	25
Review and "brush-up" of work taken some time ago	30	19
Need facts or techniques to perform present or expected tasks	59	37
Total	160	100

[a] In addition, approximately 15 courses were taken for credit without reference to an advanced degree.

indicate that, although 25 per cent of the courses were taken with a view to the completion of work for the master's degree, the practical need for information to do present and expected tasks is a more important motivating factor. This is an important fact and probably a distinguishing characteristic of in-service training programs, as contrasted with full-time undergraduate work. Related fairly closely to the practical need of securing training to do present and expected tasks are the reasons given as "information only" and "review and brush-up of work taken some time ago." These reasons connote less immediate application than "need facts or techniques to perform present or expected tasks" but do indicate a desire to keep up with recent developments without any reference to credit. Although there is insufficient proof available to indicate that better work is performed by individuals who enroll in courses without reference to credit toward an advanced degree, there is some reason to believe that a potentially higher caliber of work or of degree of application can be achieved than under some circumstances when credit is the chief motivating factor.

Inasmuch as no effort was made to correlate the reasons given for taking courses with the ages of the participants, any comments which are made in this relationship will have to be interpreted as conjectures. The authors believe that there is probably a larger proportion of the older participants, who enroll in work for reasons other than the securing of credit, than is true of the younger group of participants. Seemingly, persons motivated by a number of reasons for taking work can be accommodated in the same classes without too much difficulty as long as there is a basic homogeneity of professional backgrounds.

EVALUATION

The 69 replies to a questionnaire addressed to the 100 participants, who returned the forms directly to the training division, furnished the basis for the statement of opinions summarized in Table 2. Although the students were given free opportunity to be critical of the instruction which had been given, the evaluation which they made was distinctly favorable. Since all participation was entirely voluntary, the evaluation apparently represents a true expression of their approval.

A comparison of the reasons given for enrolling in the courses and the evaluation of the work taken is appropriate at this point. It was pointed out in Table 1 that 37 per cent of the enrollees took the work in order to secure the facts or techniques needed to perform present or expected tasks. When this stated reason for enrolling is compared with the evaluation returns, in which 50 per cent of the group expressed a positive belief that the courses contributed to "increased efficiency and quality in present or expected work," there appears to be a high correlation between objectives and achieved results. Wherever the courses did not seem to have immediate application, they did appear to contribute general background which was useful in the performance of present or expected tasks.

This over-all evaluation is not to be interpreted as complete satisfaction on the part of all enrollees with all the details of the cooperative arrangements and instructional service, but it does indicate a high degree of general satisfaction upon which future programs can be confidently developed.

TABLE 2 EVALUATION OF COURSES BY PARTICIPANTS IN THE PROGRAM

Evaluation	Number	Percentage
Increased efficiency and quality in present work	48	26
Increased efficiency and quality in expected work	44	24
Contributed to general background which is useful in performing present or expected tasks	88	48
Negative evaluation	3	2
Total	183	100

PROGRAM FOR PART-TIME GRADUATE WORK IN ENGINEERING AT THE UNIVERSITY OF TENNESSEE COMPARED WITH NATIONAL TRENDS

Although the program of part-time graduate work in engineering at the University of Tennessee grew out of a set of local conditions, the development is definitely related to the thinking which has been taking place in the professional societies and by such organizations as the Engineers' Council for Professional Development. In 1934 the United States Office of Education in cooperation with the Society for the Promotion of Engineering Education published a monograph,[5] which recognized this trend. In that monograph,[6] the authors point to the beginnings of part-time graduate study as one of the "most significant phases of the development of graduate work." During the year 1933-1934 there were 330 part-time students enrolled in 15 institutions.

A follow-up study of the enrollments of 13 of the same institutions, during the 1937-1938 academic year, indicates that 1916 enrollments were made or approximately a 600 per cent increase. Engineers have responded to the opportunity of seeking advanced work in engineering in no uncertain terms. A careful review of the institutions which are offering work of this character, however, indicates that the development is largely confined to the great metropolitan centers. Only one institution in the whole group which offers a program attracting as many as 25 students is located in a city[7] of less than half a million people. The University of Tennessee program is the only other one. There appears to be significant opportunity still untapped both in large centers as well as small centers, and particularly in the latter, to provide high-quality graduate instruction for the practicing engineers of the country.

[5] "Graduate Work in Engineering in Universities and Colleges of the United States," Society for the Promotion of Engineering Education, Pittsburgh, Pa., 1934.

[6] Ibid., chapter 6.

[7] Counting the populations of St. Paul and Minneapolis together in the case of the University of Minnesota.

REQUISITES *for* ENGINEERING LEADERSHIP

By A. R. STEVENSON, JR.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

IN ORDER to determine what further educational benefits industry should desire for its employees who already have a college education, it might first be well to state the fundamental purpose of industry which is: To make more goods for more people at less cost and to maintain sufficient profits so that new projects can be financed.

In doing this, it is also necessary to avoid technological unemployment because even aside from the humanitarian viewpoint more people must have jobs in order that more people may have money to buy industry's output. In many cases technological improvements increase employment by lowering the price so that a larger market is reached, but whenever technological improvements do reduce the number of employees engaged in manufacturing certain older lines of goods, it is necessary to have new inventions and new developments coming along to create new branches of industry, thus increasing the number of new jobs faster than the old ones shrink.

In order to accomplish all these purposes, the new ventures must create new markets. The combined economy of the nation does not gain much when new manufacturers enter old fields merely imitating existing products and throwing people out of work in already existing companies. The only justification for a new company entering an old field is when the new company can make a real contribution either in greatly improved design, better manufacturing methods, or better sales and distribution.

In order that a new project may make a real contribution to the national economy:

(*a*) The product should fulfill a real need and be designed with such useful functions and attractive features that it will quickly attain wide public acceptance.

(*b*) It must be manufactured at a low cost so that many people can afford to buy it and so that it will be worth its cost to the purchaser.

(*c*) Sufficient sales promotion and advertising must be done to sell enough to give the factory the quantity production needed to reduce the costs.

It takes ingenuity to originate such designs, analysis to avoid pitfalls, courage to go ahead, and experience to design for low cost.

The engineering is not all over when the project is under way. Continuous improvements are necessary for cost reduction and new features must be added from time to time so that the product can be sold at profitable prices in spite of lower-priced competition.

In simpler days when material and labor formed a larger part of the cost of a product, there was a fundamental called the law of supply and demand, which was supposed to determine competitive prices at a level which would give a fair profit to all concerned.

It is questionable whether the law of supply and demand under present conditions will lead to profitable competitive prices. The law is basic and must be observed, but with modern mechanization, the overhead (expense due to supervision and maintenance of buildings and machinery) is now so large in comparison with labor and material that except in boom times some manufacturers are likely to quote out-of-pocket costs in order to keep their factories busy, with the result that competitive prices sometimes are lowered to an unprofitable level.[1]

About ten years ago Colonel Kettering said that as soon as engineering improvements ceased, there would be no money in the automobile business for anyone. He said it was only the continual improvements which made it possible for companies to get profitable prices for their cars and that as soon as all the cars were exactly alike, price competition would result in nobody making money.

It may be possible, however, to make money without having something new and unusual if one has a quantity-production advantage coming from a larger percentage of the business than any single competitor.

The foregoing introduction will give the proper background for the following discussion of additional educational benefits which industry should desire for its employees who already have a college education.

COURAGE AND VISION

Our country needs courageous leadership which will develop and exploit new and unusual projects and be willing to make an educated gamble of sufficient advertising and sales-promotion funds to obtain a large percentage of the business with consequent cost and price reductions sufficient to discourage unfair imitative competition. A college team which does not have the courage to expect to win is very unlikely to win the game. Military leaders have always realized the importance of enthusing their troops to expect victory.

It is adventurous leadership which has made America great in the past and will be needed to preserve us economically as well as politically from the competition of the dictatorship countries.

Why is this emphasized in a paper on postcollegiate education? Because this courage to adventure with confidence into unknown fields is one of the first requisites for leadership in industry and engineering. Business leadership has been courageous. Men have led, have risked greatly, and have shown great fortitude under adverse conditions. The hope of high profits induced men to take great risks. Under present conditions, however, people hesitate to invest in new enterprises because they believe the possibilities of profits have been reduced by economic control and taxation. A study of history would show them, however, that, although there have been periods more favorable to business, successes were made throughout the ages in more hazardous periods by people with courage.

A recent article in the ***Saturday Evening Post*** states that the

Address at a dinner of the faculty of the College of Engineering, Carnegie Institute of Technology, Pittsburgh, Pa., February 3, 1939.

[1] This statement applies particularly to mass production and not to manufacturing as a whole.

American public in the ten-year period between 1919 and 1929 was investing an average of about twenty billion dollars every year in producers' durable goods.[2] It says that now the country is spending only about half this much annually. It is pointed out that the two and a half billion which the government is spending annually on "pump priming," although large enough to be a menace to government credit, is not nearly large enough to take the place of former constructive private enterprise.

All this proves that what the country needs is courage to go ahead with justifiable new enterprises, and it needs engineers who can invent the new enterprises and who are well enough educated to present the new enterprises in reasonable form. There is required courage born of confidence based on fundamental thinking not only along technical lines but also along sociological lines guided by a study of the social necessities which lead toward the new enterprise and the probable social effects which will result from it.

Courage, therefore, must be included among the qualities to be developed. It is not what a man knows but what he can accomplish that counts.

There are always people to discourage any new enterprise.

How can this courage be developed? By doing things that require courage. If the success of an enterprise which involves profit or loss, or in some cases life or death, depends upon the answer, then courage and responsibility are required.

Therefore, practical enterprises should be a part of post-college education.

The big electrical manufacturers try to develop courage in the recent graduates by making them responsible for the testing of large expensive equipment.

RESPONSIBILITY

This has been touched on in the discussion of courage. It includes much more. A man must feel a real responsibility for his work. One way to develop it is to give young men a chance to be responsible in small things where they can get the thrill of succeeding. There are too many bosses who try to do all the deciding and thus fail to give their assistants a chance to be responsible partners. In such departments there is danger of chaos when the boss moves on, unless an outsider is brought in.

It must be remembered that where there is no authority, there is no responsibility.

CHARACTER

The importance of this is so universally recognized that it seems platitudinous even to mention it. In these cooperative undertakings, it is necessary for mutual confidence that all the cards be face up on the table. The condition of Europe is an example of the chaos which occurs when statesmen cannot trust one another. In our own country, one of the causes of the continued depression is the lack of mutual confidence between business and government.

In developing character we use the old axiom that people tend to become what you think they are. In our own company as in most large corporations, we simply assume that every one is honest.

ENERGY AND WILLINGNESS TO WORK

Genius has been defined as "an unlimited capacity for hard work." This is not a complete definition but it does emphasize an important point. Most all great men like Lamme, Westinghouse, Carnegie, Steinmetz, and Edison were hard workers. It has been said that "inspiration is mostly perspiration."

PERSONALITY

In the days when the cave man went out by himself to kill game, perhaps personality was not important, but today when almost every worth-while undertaking requires the cooperation of many people, the ability to get along with others and persuade them to cooperate is a necessity. Some people appear naturally to have more tact and personal magnetism than others, but it would be an unpleasant defeatist philosophy to assume that personality traits cannot be improved by proper example and supervision.

Some people say that men never change and must be taken as they are, but they are wrong. Even older men improve considerably in personality with proper encouragement and supervision. It is obviously much easier to persuade a young man just out of college to change his attitude and methods of getting along with his fellows. The methods of polite usage are more necessary to avoid a bad impression on first encounters but no amount of superficial politeness will make up for insincerity. Likes and dislikes are largely intuitional. If one likes and respects one's associates, the feelings will probably be reciprocated.

It is said that an organization reflects the personality of its leaders. If the leaders are polite and considerate to every one, the young men absorb the same attitude.

It would be a fine thing for the engineering profession if more young men of naturally outstanding personalities could be attracted into it to become the future leaders.

COMMON SENSE

It is so easy to go astray. A man should always be trying to get a perspective, a sense of proportion, a sense of humor. A perspective is impossible without a broad view. A man must know many things outside his own specialty in order to see his own specialty in the proper proportions. Sometimes it is hard to see the forest for the trees. To get a proper sense of proportion, it may be necessary to neglect details temporarily and make approximations. One should usually try to guess the answer to a problem before trying to calculate it accurately. And, finally, every answer should be examined in the light of common sense. In this way, bad slips in elaborate calculations can be detected. The accuracy of one's judgments can probably be greatly improved with practice.

Amazing solutions of problems are credited to the subconscious mind. No thinking mechanism, however, can produce accurate results from inaccurate or wrong data. If the subconscious mind is to produce correct intuitional judgments, it is necessary to feed it accurate facts. If vague or incorrect information floats into the subconscious mind without challenge, it pops up years later warping the judgment. Having been allowed to lie in the mind for years, it has an appearance of primordial verity when it does pop up.

The people with the best common sense and intuitional judgments are those who make a habit of challenging new information and at least briefly examining its verity before letting it slip into the storehouse of the mind.

If one is thoroughly familiar with a few fundamentals, it is often easy to decide quickly on the probable accuracy of various statements.

Fundamental thinking is not necessarily mathematical. It depends largely upon having a clear physical picture and a critical attitude of mind that refuses to accept hearsay information without proof.

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[2] "One-Legged Nation," by Harry Scherman, *Saturday Evening Post*, Dec. 31, 1938, p. 23.

A recent example of the lack of fundamental thinking in the field of engineering is rather amusing. Some biologist observed the flight of the deer botfly and estimated from his visual observation that it flew 800 miles an hour. This figure has been quoted, copied, and broadcast for several years. Dr. Irving Langmuir[3] subjected this statement to a series of critical fundamental questions, pointing out first that the velocity of sound is only 740 miles per hour and that nothing propelling itself by wings can fly faster than its buzz. If the biologist had used a fundamental approach from any one of a number of angles, he would have noticed his error; for instance, if he had calculated the power consumed, he would have found it to be about one-half horsepower; if he had assumed a reasonably high thermodynamic efficiency, he would have found that the fly must have consumed one and one-half times its own weight of food each second to deliver the power required; and, if he had made a little experiment, such as was tried by Dr. Langmuir, of attaching a piece of solder about the size of a deer fly at the end of a piece of string and swinging it around his head, he would have found that the solder became a faint blur at 25 miles per hour, a faint line at 40 miles per hour, and completely invisible at 60 miles per hour. All of these avenues of attacking such a problem are fundamental, but it requires a good knowledge of basic physical laws and an ability to think for one's self to apply them critically even in such a simple case as this.

ABILITY TO THINK FOR ONE'S SELF

This can also be cultivated by encouraging the young men to go back to easily recognizable fundamentals and follow the thought through by simple logical steps. Even the most complicated thoughts can be broken down into a succession of recognitions between simple facts. In the interests of speed, sometimes these simple intermediate steps are short-circuited by people completely familiar with them.

In learning to think for himself, a man should be careful to break down each logical sequence into sufficiently simple steps so that he understands thoroughly each step. If he takes anything for granted because the book says so or the teacher says so, the ability to think for himself is thereby endangered.

In later life, it is often necessary to take some other person's word for something but, before storing the information away, it should be tagged with a label "second hand and subject to question."

In scientific work, it is often necessary to project a hypothesis or approximation on trial and use it, but one should always remember that its universal application has not been proved and should be open-minded to new facts that might disprove it.

People used to accept the hypothesis that the world was flat and they made successful journeys on that assumption, but Columbus was open-minded to the idea that it might be round and discovered a new continent.

INGENUITY AND INVENTIVENESS

If industry is to be expanded into new fields, these qualities are of supreme importance. How men with these qualities can be selected and developed would make a long discussion by itself.

Old men make many improvement inventions, but it is said that really outstanding discoveries are all made by young men. How can they be started inventing at an early age while they still have this faculty? The colleges do almost nothing to discover or develop it. When professors are asked: "Does this young graduate have intuition and inventiveness?" the reply is usually: "I don't know. There is no opportunity in the college course for him to show it."

It is said that necessity is the mother of invention. It is, therefore, important to create situations where necessity is able to operate. This arises only in the solution of practical problems.

In the General Electric Company there has been established a mechanical-design course. The men in this course are given class work in materials and processes because these two elements enter so greatly into ingenious design. But the most important element is the assignment of students who have sparks of ingenuity to work in direct contact with some of the men who are ingenious and inventive designers.

This is in line with the remark attributed to James A. Garfield:[4] "My definition of a university is Mark Hopkins at one end of a log and a student at the other."

The value of the doctor-of-philosophy degree has been more widely recognized by industry in the fields of physics and chemistry than in engineering. The reason perhaps is that these fundamental sciences can more easily be practiced in a college laboratory. The science professors do researches which even though theoretical may be called practical in the best sense of the word because they lead to useful results. The graduate students associating with these professors get the stimulus of helping in real creative enterprises.

The doctors of medicine, law, chemistry, and physics get their stimulus largely from men who are practicing their professions.

Engineering has a tendency to deal with projects of such magnitude that it is hard to handle them in a laboratory.[5] The teacher of engineering, therefore, is often not a practicing engineer who can stimulate his pupils by sharing with them real creative enterprises. Graduate work would be greatly benefited if the professors handling it could all be engaged part time in practical pioneering adventures.

Engineers who will outdistance all competitors are needed. As Kipling put it:[6]

"They copied all they could copy
But they could not copy my mind
And I left them sweating and stealing
A year and a half behind."

EXPERIENCE

So often when a new enterprise is started, plenty of young men with good theoretical background can be found. But the few really good men with practical factory experience usually are indispensable where they are. Experience hardly comes under the head of education. An effort should be made to give young men a chance to acquire it. It can best be acquired in partnership with an older man. The fact that the young man is able to calculate complicated problems gives him a quicker opportunity to associate with older men of experience from whom he can learn more practical things. There are a good many informal partnerships in the company between an older man with a lifetime of experience and a younger man who can calculate. The older man is willing to spend time helping to educate the younger man in practical matters because the younger man has the theoretical equipment which makes him useful to the older man. This prevents a

[3] "The Speed of the Deer Fly," by Irving Langmuir, *Science*, vol. 87, March 11, 1938.

[4] According to well-established tradition, James A. Garfield is quoted as having made this remark at an alumni dinner in New York City in 1872.

[5] Some of the best engineering inventors do make progress by building apparatus and experimenting with their own hands. On projects where this is possible, it is valuable.

[6] From the poem "The Mary Gloster."

one-sided relation. Just as in social intercourse the favors should not be all one way, so the younger man should have the satisfaction of making a real contribution at the same time that he is receiving an education in practical matters and experience.

CULTURAL SUBJECTS

The ability to use the English language is of such great importance in securing cooperation that it should be emphasized particularly both in written and in oral work. Practice in public speaking is very beneficial.

The other cultural subjects are also of importance in any well-rounded personality, giving perspective and charm, but industry feels these are subjects which the colleges should teach both to undergraduates and in night schools for the postgraduate.

TECHNICAL ABILITY

You probably wonder why this has been left to the end. It is of great importance but it is much easier to find and to develop. It is more in the nature of a set of tools which a man can learn to use.

The need in the General Electric Company for more men with a good technical education capable of thinking for themselves gradually became apparent. In 1922, Dr. Doherty and I started the Advanced Course in Engineering.

The whole method of teaching has largely been based on ideas obtained from Dr. Steinmetz and Dr. Berg. The effort has always been to make the students think for themselves. As far as possible the problems are taken from the actual work of the company. Mathematics is taught as a means to their solution. Every subject is sifted to its simplest fundamentals and the students are shown how the whole subject is derived from one or two fundamental principles, such as the law of conservation of energy and a few definitions.

The *A* class reviews mechanics, thermodynamics, fluid flow, electricity, and magnetism from this fundamental viewpoint, with practical problems as illustrations. These practical problems differ from textbook problems in that the analysis does not follow the lecture precisely. Common sense has to be used in making approximations and common sense has to be used in judging the correctness of the answer. Some of them cannot be fitted into mathematical formulas, but are solved by approximate step-by-step methods. Confidence is obtained that an answer to any practical problem as nearly exact as desired can be found.

Ten or fifteen of the *A*-class graduates are selected for two further years of study in the *B* and *C* classes. While the *A* class is the same for every one, the *B* class is sometimes divided into electrical, thermal, and high-frequency sections. In the *C* class, the electrical and thermal students join in a mechanical section while those interested in high frequency have a special high-frequency section.

The men in the *B* and *C* classes are circulated from department to department on approximately three- or four-month assignments.

GOOD FOR MEN AND COMPANY

This circulation is good for both the men and the company. The men get a broader idea of what engineering is and have a chance to find out which departments they like the best. The department heads get acquainted with a great number of men and have a chance to decide which ones they want the most. The final placement in departments is usually the result of mutual desires on the part of the man and the department. The circulation also widens the man's circle of acquaintances so that in future years he can obtain the benefit of advice from close personal friends in other departments.

This whole educational project is coordinated with a consulting-engineering department.

It is felt that engineering teachers in industry should be practicing engineering just as the professors in medical schools are usually practicing medicine and the professors in law schools very often practice law. John Dewey,[7] the famous psychologist, said that if theory is taught separated from practice, it is almost impossible to expect the student to apply the theory to practical problems, whereas if the theory is taught in the first place by practical men in relation to practical problems, the student automatically learns how to apply the theory.

In the advanced course this is secured by using practical problems to illustrate the theory and by assigning the men to work for various leaders in the regular engineering departments of the company. All the men in the courses are making such contributions that there is little difficulty in persuading the departments where the men are assigned to accept the cost of their salaries. This feeling that a man is contributing his share is of great importance.

CONCLUSION

We have all felt the disappointment of going on a vacation in search of happiness only to find the experience below expectation. Those who search primarily for security[8] are the least likely to get it while the audacious adventurer is resourceful enough to gain security by his own wits. Many, indeed, are the examples of the philosophy that most worthwhile things in life are obtained best as by-products of striving for some other more primary objective. It is true in engineering education. If the student's main objective is to learn, he can learn most and quickest by reading the work of others; the better it is explained, the fewer thoughts he need originate and the faster is his progress. That knowledge so gained is of little value to him later is recognized, but, if his primary objective is to obtain a useful result for some one, he may have to think enough to fix firmly the knowledge and the fundamentals for future use. A professor who is a current leader in engineering has such problems; he can by his own preeminent ability lead and challenge the brilliant student and finally, if he is a true leader, he can inculcate in the student a sense of moral and social responsibility toward mankind, which is an essential for those who are to shape our technical advance.

In other words, correct postcollege education is a by-product of producing useful results in association with an inspiring leader of outstanding ability on some worth-while pioneering adventure.

Industry needs courage, character, energy, and the other qualities which have been discussed. Industry prospers in proportion as it serves the public. There is plenty to be done. On his deathbed, Cecil Rhodes said: "So much to do, so little accomplished." The young men coming to industry should ask themselves: "What can we do to help?"

[7] "How We Think," by John Dewey, pp. 52 and 53, D. C. Heath & Company, Boston, Mass., 1933.

"The assumption that information which has been accumulated apart from *use* in the recognition and solution of a problem may later on be freely employed at will by thought is quite false. The skill at the ready command of intelligence is the skill acquired with the aid of intelligence; the only information which, otherwise than by accident, can be put to logical use is that *acquired in the course of thinking*. Because their knowledge has been achieved in connection with the needs of specific situations, men of little book learning are often able to put to effective use every ounce of knowledge they possess; while men of vast erudition are often swamped by the mere bulk of their learning, because memory, rather than thinking, has been operative in obtaining it."

[8] "The Perils of Security," baccalaureate address by Dr. Harold W. Dodds, president of Princeton University, June 20, 1937.

UNINVESTED SAVINGS[1]

By DONALD S. TUCKER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HEARINGS before the Temporary National Economic Committee (TNEC) have aroused widespread interest in the possibility that some savings may fail to be invested. Among engineers this interest has been sharpened by the appearance of a booklet published by the Machinery and Allied Products Institute.[2] Trade publications have long been a valuable source of information with respect to the trade; but it should be noted that a trade organization has in this instance undertaken to present a lengthy contribution toward an understanding of the general welfare.

Because the pamphlet here reviewed is frankly a polemic and starts therefore only where the dispute starts, and because the dispute in this instance starts only in the middle of a chain of reasoning, some introduction will be needed by the non-professional reader in order to understand the issues debated here. It is the chief purpose of this review to supply the common ground from which the debaters start. In the interests of a wider circulation it is unfortunate that some such introduction was not included within the book itself.

Savings that have not yet been invested present a problem substantially new. Idle investment money may have existed for many centuries; but three things have happened in recent years to sharpen our interest: The nature of such uninvested money has been more clearly identified; its magnitude has fluctuated by huge percentages during the last decade; and, finally, economists are now suggesting that variations in the volume of these uninvested funds are a principal cause—perhaps even the principal cause—of alternations in general business prosperity and depression. The nature and behavior of these funds are therefore of interest to engineers.

TWO MAJOR USES OF MONEY

Money (including the checking accounts deposited in commercial banks) may be available either for spending or for investment. Only very rarely is a sum of money equally available for both purposes. The man who by twelve months of sacrifice has saved \$1000 may buy a bond; but he does not willingly use his savings for current expenses. The man who receives a salary check of \$400 may wish to make an investment, but money received as salary may well be needed for current expenses. The two major uses of money differ therefore in their character: Savings are used for investment; but money received as income or revenue must be used normally for current expenses.

Money available for current expenses creates apparently no problems for the community. Recipients of such money buy goods; producers of such goods pay out their receipts either as income to new spenders or as payments for raw materials and supplies whose producers in turn are compelled to make similar disbursements. Eventually, all money spent by the recipients of wages, dividends, rents, and the like, comes back to some member of the community as income. Production is both stimulated and directed by use of the money devoted to current expenses.

Financial savings are not so certain to cause production. Money available for investment may be used in any one of three ways, which, for want of more convenient terms, we shall call real investment, paper investment, and hoarded investment.

REAL INVESTMENT

Real investment occurs when financial savings are paid out as income to some one who assists in producing a new capital asset. The man who invests \$10,000 in building a house makes therefore a real investment. Carpenters and sellers of materials regard the money they receive from him as income or revenue. They spend such receipts, as other income is spent, chiefly for the purchase of goods. Production will be stimulated by their expenditures and by the subsequent expenditures of those with whom they spend. The money, formerly financial savings, is converted into ordinary income-and-expense money by real investment.

PAPER INVESTMENT

Paper investment, the second possible use of financial savings, transfers financial savings but fails to convert them into money available for ordinary expenses. Purchase of a bond would be paper investment. The seller of a bond will view his receipts chiefly as capital, not as income. It is true of course that these receipts may enable him subsequently to build a house or to make other real investment, but purchase of some preferred stock or other bond is equally possible. Corporations that sell new issues, may of course use the proceeds for physical construction; but purchase of some going corporation or reconstruction of their financial plan is equally possible. Sellers of a going business and former owners of securities retired regard their receipts chiefly as capital. They do not pay out this money capital in the manufacture of new securities or corporations. Paper investment results therefore in transactions that may be recorded; but, unless followed by subsequent real investment, it fails to create production and income.

HOARDED INVESTMENT

Hoarded investment money consists chiefly of checking accounts that are not being used by the owner. Money is held occasionally as though it were an investment. Anyone who fails to find an attractive opportunity for real or paper investment may thus hold money. When business prospects seem dark, as in the winters of 1931-1932 or 1937-1938, the volume of such hoarding may become large. This hoarded investment money must not be confused with the thing which bankers call hoarding. This money is not withdrawn from banks; it fails simply to be transferred by check. Growth of hoarded investment money diminishes the average turnover of all bank deposits, but does not affect the magnitude of such deposits. The failure of this money to be offered for goods diminishes the demand for goods, the output of commodities, and the income that might be created.

In the long run all financial savings may perhaps be devoted finally to real investment; but if money were habitually hoarded for five years before investment, the volume of

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Saving and Investment in the American Enterprise System," Machinery and Allied Products Institute, 221 North LaSalle Street, Chicago, Ill.

hoarded investment money would be always large. The amount of money available for financing production is the remainder left after hoardings have been subtracted from total money. Growth of the volume of hoarded investment funds may therefore curtail production.

Money held available for paper investment resembles hoarded money in its effect upon production and the national income. If men transfer their investments so frequently that one tenth of their fortunes is on the average held in cash, then money equal in value to one tenth of their fortunes is withdrawn from production. Since the wealth of the United States exceeds 350 billions while total commercial bank deposits are less than one tenth of this sum, it would become impossible for producers to make any sales whatever if all owners of property were successful in liquidating one tenth of their fortunes at present prices and in hoarding the proceeds. Money available only for paper investment is in its effect identical with hoarded investment money. It fails to create production or income. Paper investment deserves, however, some mention here because hard-pressed readers tend normally to confuse it with real investment, instead of identifying it correctly as (temporarily at least) a form of hoarding.

HOARDED INVESTMENT SHOULD BE KEPT AT MINIMUM

Maximum income can arise for a nation only if hoarded investment money is kept at a minimum. To accomplish this it is essential that money shall be invested (i.e., used for real investment) about as rapidly as it is saved. Some store of hoarded money can be afforded just as we can afford many small luxuries that do not contribute to our efficiency. Peril arises, however, if the rate of saving exceeds the rate of investment because a continuing difference of this kind may cause the store of hoarded investment money to be augmented progressively. To induce more rapid investment may then readily become a matter of national importance.

Reduction of commodity prices operates by two methods to quicken the pace of investment. Reductions in the cost of investment goods may diminish taxes and depreciation costs as well as interest charges. A man whose income remains at \$4000 per year may refuse to buy a house costing \$9000, but may be induced to purchase if an identical house is offered at \$7000. Price reduction may thus operate directly to stimulate investment. Reduction of the prices of consumers' goods is also useful because it permits people to buy more goods even if their money incomes have not yet been increased. Production of these goods in augmented volume makes existing facilities inadequate and thus operates indirectly to make investment more attractive.

Investment arising from either of these stimuli diminishes hoardings and augments money income. Such increments of income enlarge further the demand for goods, make more facilities inadequate, make additional investment attractive, and thus convert depression into prosperity. Percentage diminution of money income 1920–1922 did not differ greatly from that of 1929–1932; but prices were more flexible in the former period and that depression was therefore less severe. In the more recent depression the prices of farm products proved again to be flexible; but the prices of many manufactured goods, industrial equipment, and construction materials were sluggish and depression was thus prolonged.

EFFECTS OF DEFICIT SPENDING

Prolongation of the depression as well as its severity forced the adoption of remedial measures. Relief is costly, and the collection of additional tax revenue in periods of business depression is difficult. Some deficit spending is perhaps inevitable in severe depressions; but the deficit spending of governments and of private corporations operates also to convert financial savings into ordinary money. Corporations and governments borrow capital funds and pay these out as income (to others) or expense (to themselves). Such payments tend to end the depression as well as to provide relief. It is at this point that political dispute arises. Opinions differ as to the purposes proper for the deficit spending of governments.

If the dispute discussed in this pamphlet were with respect to this political issue, no introduction would have been necessary. In this instance it is possible that the opponents may agree on the major political issue. The political issue is, at least, not the question debated here. In testimony before the TNEC Professor Hansen suggested that certain secular trends may in the future operate to deter the investment of family savings. Such trends include the cessation of territorial expansion, diminution in the growth of population, the declining rate of growth of consumer credit, and the cessation of investment abroad. The executives of several large corporations, such as General Electric, U. S. Steel, and General Motors, added to his list by their testimony that some business corporations will no longer need to appeal to private investors for additional capital.

Recognition that deficits may occur in private investment was not original with any of these witnesses. Presentation of the possibility and nature of such deficits was Professor Hansen's chief contribution; but he shared with these business executives and with others the burden of supplying also some basis for estimating the magnitude that might be expected of such deficits in future years. It is the magnitude suggested by the testimony of these witnesses that is here attacked. Accuracy of the chief element of Professor Hansen's testimony is assumed tacitly in this pamphlet; but tacit admissions are not sufficient in a book designed for general distribution. The obviousness of the personal animosity displayed also in other ways against Professor Hansen (though not against other witnesses) is unfortunate because it will hamper any public acceptance of this pamphlet's conclusions.

The testimony of these business executives and others, when added to Professor Hansen's testimony, led inevitably to an inference that deficits of private investment would continue to be large. In parts I–VI this pamphlet describes offsetting influences which may cause this deficit in the long run to be of negligible magnitude. Although its authors indulge later in some speculation of a more general character, the evidence presented is limited strictly to this one point—the probable magnitude of the possible future deficits of private investment.

SLUGGISH PRICES AND DEFICITS

The stubborn sluggishness of many prices and the magnitude of recent deficits of private investment make estimates of long-run tendencies of this kind significant for the national welfare. The argument presented in parts I–VI of this pamphlet with respect to the offsetting influences deserves the highest praise. To this argument has been appended a disquisition on the immediate situation. This caudal appendage (part VII) sounds in places as if its authors were not even familiar with the issue debated in the preceding pages. Is this pamphlet then perhaps the work of several men? Could any man capable of parts I–VI ever descend to the level displayed in portions of part VII?

This booklet must be criticized for three defects: Lack of the introduction necessary for general readers, unfairness in dealing with one opponent, and, especially, the failure to delete Part VII. The glaring character of these defects should not, however, blind us to the fact that this pamphlet contains also material of substantial value. Its publishers are to be congratulated on the production of this material.

WORKING *for* BETTER ENGINEERS

Spirit of Seventh Annual E.C.P.D. Meeting Emphasizes an Improved Profession

AT THE Seventh Annual Meeting of the Engineers' Council for Professional Development, held in the Engineering Societies Building, New York, N. Y., Oct. 20, 1939, the principal matters of business were the election of officers and chairmen of committees, announcements of changes in personnel of the Council, and reports of committees, which have become the annual feature upon which major interest centers.

John P. H. Perry, of the Turner Construction Company, was reelected chairman of the Council and R. E. Doherty, president, Carnegie Institute of Technology, is to fill the office of vice-president for the coming year. In accordance with the plan of rotating the secretaryship among the national secretaries of the participating engineering societies, C. E. Davies, secretary, A.S.M.E., once more assumes the duties of that office. Mr. Davies was the first secretary of E.C.P.D. George T. Seabury, secretary, A.S.C.E. becomes assistant secretary of E.C.P.D. The United Engineering Trustees, Inc., continues to perform the function of treasurer.

POTTER SUCCEEDS COMPTON AS CHAIRMAN OF ENGINEERING-SCHOOLS COMMITTEE

Only one change in the chairmanships of the four principal committees was made; A. A. Potter, dean of engineering at Purdue, past-president A.S.M.E., succeeds Karl T. Compton as chairman of the important Committee on Engineering Schools. New appointees to this committee are Dean E. L. Moreland, of M.I.T., Dean J. W. Barker, of Columbia, and President R. E. Doherty, of the Carnegie Institute of Technology.

C. F. Scott continues as chairman of the Committee on Professional Recognition, as do O. W. Eshbach, John C. Arnell, and R. L. Sackett, respectively, of the Committee on Professional Training, the Junior Committee on Professional Training, and the Committee on Student Selection and Guidance. D. B. Steinman and H. C. Parmelee were reappointed to the Committee on Professional Recognition, and C. R. Beardsley, of the Consolidated Edison Company of New York, Inc., was added to it. New members of the Committee on Student Selection and Guidance are President A. R. Cullimore, of the Newark College of Engineering, and George B. Thomas, personnel manager of the Bell Telephone Laboratories. The new appointees to the Committee on Professional Training have not as yet been announced:

For the coming year the Executive Committee will consist of Enoch R. Needles (A.S.C.E.), G. B. Waterhouse (A.I.M.E.), A. R. Stevenson, Jr. (A.S.M.E.), J. F. Fairman (A.I.E.E.), R. E. Doherty (S.P.E.E.), B. F. Dodge (A.I.Ch.E.), and C. F. Scott (N.C.S.B.E.E.) with Mr. Perry as chairman.

New appointees to the Council are G. W. Burpee (A.S.C.E.); J. L. Christie (A.I.M.E.), R. L. Sackett (A.S.M.E.), O. W. Eshbach (A.I.E.E.), C. M. A. Stine (A.I.Ch.E.), R. A. Seaton (S.P.E.E.), and C. F. Scott (N.C.S.B.E.E.). Messrs. Burpee and Sackett have, in effect, been reappointed, as they have been filling the unexpired terms of Messrs. Winsor and Hirshfeld, respectively, recently deceased.

On invitation of Dean W. N. Jones, the Council voted to hold its eighth annual meeting at the Carnegie Institute of Technology, Pittsburgh, Pa., on Oct. 24, 1940.

Committees were approved to study the desirability of extending affiliations of the Council with other engineering groups in this country, in Canada, and overseas.

Memorials on the deaths of C. F. Hirshfeld and Frank E. Winsor, former council members, were adopted by rising vote.

PROFESSIONAL RECOGNITION DISCUSSED BY SCOTT

In presenting the report of the Committee on Professional Recognition, C. F. Scott, chairman, reviewed briefly the past activities of the committees that were directed toward the development of "methods whereby those engineers who have met suitable standards may receive corresponding professional recognition." The committee, he said, had urged action relating to the adoption of the "minimum definition of an engineer," conformity to proposed standard grades of society membership, uniformity in new registration laws, amendment of existing registration laws, and simplification and uniformity in engineering-school degrees.

The report next considered broad questions involved in what is meant by the profession of engineering, and the means by which the professional ideal might be developed. This was the concern of the engineering societies, of engineering registration (both boards and registrants), of engineering schools, and of engineering students, it was stated.

"Engineering progress," the report said, "owes much to concentrated efforts of many groups in their specialties without retardation by association with a large mass. We need a balance between diversity and unity, which will insure the advantages of each."

As to the concern engineering societies have in the development of the professional idea, the report said: "The societies might profitably crystallize more definitely their ideas of the profession, comparing their ideals and emphasizing what is common rather than their differences. They may well inquire how much the unity and the solidarity of the profession of which they have been the sponsors has suffered through their individual disregard of conformity; and they may also consider what action is expedient for the future."

Following the listing of a number of concurrent activities of several participating bodies in E.C.P.D., the report closed with a section on policy and program, from which the following excerpts are quoted:

> The committee does not feel constrained to contribute something new or revolutionary from year to year. At present it contents itself with focusing attention on its past contributions and giving further thought to the problems in its field.
>
> The committee proposes to gather further data of the processes associated with recognition of engineers and point out the need for correlation. It may consider further the situation in other professions.
>
> Haste is ill-advised when traditional ideas and practices are to be coordinated with what is new and different; when autonomous groups are to cooperate voluntarily, contemplation and understanding must precede procedures and rules.
>
> The scope of engineering is so comprehensive, its interests so varied and its recent evolution has been so rapid that realignment is most difficult. There must be freedom for development; regimentation would be deadly. But we may seek the fundamentals which are essential to a unified profession.
>
> Our committee, standing at the gateway of the profession of engineering, is concerned with goals of our other committees; that more able re-

cruits be secured; that the schools give better training; that self-development in after-graduation experience may be enhanced; also that those who grant professional admission shall call for high standards of competency.

While the committee may appear to concern itself with the details and nomenclature of recognition it is fully cognizant that its major aim is the enhancement of the professional status of the engineer.

Engineering must adjust to expanding science, to advancing technology, and to urgent demands and responsibilities in economic and social fields.

In this continuing evolution we seek not only individual qualifications but adjustments between engineers themselves, minor details in the great whole, which will insure a forward step in the usefulness of the profession, to the end that engineering effort may bring scientific discoveries to full fruition in better ways of living.

ESHBACH REPORTS ON PROFESSIONAL TRAINING

In the report of the Committee on Professional Training, Ovid W. Eshbach, chairman, said that the committee had expressed the opinion a year ago that the development of interest among younger members would depend largely on the initiative taken by local organizations. The proposal was made that before undertaking further major activities, the educational committees of the societies be solicited to undertake a joint study of the growing local activities with a view to ascertaining their nature, the facilities available, their sponsorship and response, and to crystallize opinion as to future policy, the function of the educational committees, methods of coordination, and possibilities of increasing society memberships.

This proposal had met with a favorable response. For some months, the report said, study of the form of inquiry had been in progress and a draft, a copy of which was included in the report, had been sent to the committees of the societies.

The report also included a summary statement of the observations of W. C. Johnson, of Princeton University, who, with the committee's endorsement, made a study of postgraduate training in industry. Mr. Johnson's purpose was to study at first hand the opportunities provided by industry for the "breaking-in" and training of young engineering graduates. While on this mission Mr. Johnson traveled some 12,000 miles and interviewed many of the larger industrial organizations, as well as some of the smaller ones. The study was later extended by means of a questionnaire, and included the majority of the important electrical manufacturing firms and public utilities in this country, and a score of the more important nonelectrical manufacturing companies.

Mr. Johnson's conclusions, quoted from his report, follow:

The young engineer just entering industrial life lacks experience with industry in general, and with his own company in particular. His practical education is just beginning, and he can often use with profit a more extended technical education. The value to the student of a well-planned training program is unquestioned; the value to the employer has been amply demonstrated in the experience of the companies which have such programs by a decreased unproductive period, by a better informed and more productive staff, by better coordination between departments, as well as in many other ways, both tangible and intangible. It is significant that these organizations regard student training as indispensable. The usual argument against such training is its cost, but an adequate course of instruction need not be expensive, even for the smaller companies, if it is well-planned.

A complete training course should include both an experience program and an instructional program, with the latter providing training in the organization and business administration of the company, instruction in the company's products, and their problems of manufacture and application, and for those students who show exceptional technical ability both the opportunity and encouragement for continuing their technical education, perhaps in company schools, or in cooperation with a local college or university.

Present industrial training courses are particularly weak in business and organizational training, and relatively little attention is paid to the continuation of the student's habits of study and to his opportunities for additional technical education. These deficiencies are important in the small as well as in the large organization. Their remedy is a matter of planning rather than expense, and the necessary effort will, in time, be amply repaid in many ways.

GUIDANCE BOOKLET UNDER REVISION

For the Committee on Student Selection and Guidance R. L. Sackett, chairman, reported developments in the counseling of high-school students, particularly mentioning numerous organizations that had undertaken such work, and reviewed the progress that had been made in revising the guidance booklet, "Engineering: A Career—A Culture," which was originally published in 1932 by The Engineering Foundation. Of the original edition of 100,000 copies, he said, only a few thousand remain. Provision should be made for a new edition of what is practically a new pamphlet.

Copies of the revised text of this pamphlet, in which had been incorporated the most constructive suggestions from about 100 persons, were distributed to Council members, and after discussion, it was decided to change the title to read, "Engineering as a Career," and to circulate copies of the text to members of the governing boards of the engineering societies participating in E.C.P.D., requesting comments within three months.

The final portion of the committee's report dealt with the problem of the selection of engineering students and contained a plea that engineering societies give voice to their approval of efforts on the part of engineering schools to discriminate in the admission of students. On Dean Sackett's motion the Council voted to send to the boards of the societies participating in E.C.P.D. the Council's commendation of the institutions that were making an effort toward proper selection of students.

COMPTON REVIEWS PROGRESS OF ACCREDITING PROGRAM

Since October, 1938, said Dr. Compton in presenting the report of the Committee on Engineering Schools, a total of seven engineering curricula had been inspected and 74 curricula already provisionally accredited had been reinspected. To date, he reported, 144 out of a total of 150-odd degree-granting engineering institutions had applied for inspection and 687 curricula had been acted upon or were under consideration. Of these 433 had been accredited unconditionally, 82 accredited for limited periods, and 172 had not been accredited.

In a discussion of progress made during the year in the solution of specific problems, the report revealed a revised procedure in the accrediting of chemical-engineering curricula, referred hopefully to the possible appointment of a joint committee representing E.C.P.D. and the Society of Agricultural Engineers whose object it would be to clarify the accrediting of agricultural-engineering curricula, and stated that the Committee on Engineering Schools was convinced that the accrediting of technical institutes should be done by representatives of the technical-institute group.

Announcement was made in the report of the forthcoming report, prepared by D. C. Jackson, on a study of present status and trends in engineering education, and based on the factual material assembled by the committee in its work of accrediting. A review of this report will be found on pages 912 to 914.

That the task of accrediting is a continuing one was made clear in a section of the report devoted to activities and policy for the future. In many ways, it was stated, the maintenance of a reliable list of accredited curricula was more difficult than the preparation of the first one. However, it was pointed out, if the program were to meet with ultimate success, this plan of continuing appraisal would have to be carried out assiduously. Other problems touched on in the report and regarded as being worthy of attention were: (1) Ways of meeting opposition on

D. S. BRIDGMAN

E. S. BURDELL

R. C. MUIR

A. A. POTTER

the part of engineering schools to the procedure of accrediting by avoiding unnecessary detail in reinspections, by adhering to the committee's original basic principles, and by giving prompt and effective service to institutions asking help and advice; (2) the development of a policy toward evening and cooperative curricula; (3) the tendency of some secondary schools to provide inadequate training for students preparing for engineering work; and (4) the opportunity to extend and develop advisory service to institutions.

Another report of the committee relating specifically to the accredited undergraduate engineering curricula was discussed in executive session of the Council, and the lists of 525 curricula in 118 institutions, arranged by institutions and by curricula, were released on November 1. These lists may be obtained from the E.C.P.D., 29 West 39th Street, New York, N. Y.

Engineering schools which were added to the list in 1939 include Alabama Polytechnic, Auburn, Ala., electrical and mechanical engineering; Northeastern University, Boston, Mass., civil, electrical, industrial, and mechanical engineering; Pratt Institute, Brooklyn, N. Y., electrical and mechanical engineering; Southern Methodist University, Dallas, Texas, civil, electrical, and mechanical engineering; University of Tulsa, Tulsa, Okla., petroleum engineering; Vanderbilt University, Nashville, Tenn., civil, electrical, and mechanical engineering; and U. S. Coast Guard Academy, New London, Conn., general engineering. The last curriculum includes, according to the report, "satisfactory training in engineering sciences and in the basic subjects pertaining to several fields of engineering; it does not imply the accrediting, as separate curricula, of those component portions of the curriculum such as civil, mechanical, or electrical engineering that are usually offered as complete professional curricula leading to degrees in these particular fields."

EDUCATORS AND INDUSTRIALISTS SPEAK AT E.C.P.D. DINNER

About 50 members of the Council and their guests attended the annual dinner of the E.C.P.D. held at the Engineers' Club on the evening of October 20, where they were addressed by two engineers and two industrialists. Mr. Perry acted as chairman. In his introductory remarks he reviewed some benefits that derive from the impact of lay thinking on educational development, and expressed his conviction that contact between laymen and educators would bring about desirable results.

Dean Potter's remarks concerned the mutual objectives of engineering societies which were being sought through such organizations as the E.C.P.D. He reviewed the work and future program of the committee on Engineering Schools, and paid glowing tribute to Dr. Karl T. Compton for his successful leadership as chairman of the committee, a position to which Dean Potter had just been appointed.

Certain statistics covering the engineering graduate in the Bell System were presented, with appropriate comment, by D. S. Bridgman, staff assistant, Personnel Relations Department, American Telephone and Telegraph Company. In the twenty years from 1920 to 1940, Mr. Bridgman estimated that the proportion of all men 22 years of age graduated from colleges would almost triple. Such an increase would mean that college graduates could not expect the favored position they had had in the past. It was his opinion that this implied that the objectives and satisfactions of many of these graduates would have to be adjusted to the new situation. He believed, as did the boys and their parents, that for those with the ability to realize on a college education, such an education added something substantial to their native capacity for logical thought and breadth of view in dealing with the problems of business. A business like the Bell System, he continued, had to draw upon such ability and training. It was his hope, he said, to find with this ability and the technical background, interest in the broad problems of supervision, personnel, and public relations and management that were critical today, and a willingness to develop within the business the background needed to cope with them.

Speaking on the development of professional competency and the engineering schools' responsibility in it, Dr. Edwin Sharp Burdell, director of Cooper Union, New York, N. Y., advocated application of the principle of "scientific humanism" to engineering education. He spoke effectively against attempts to separate into different educational programs and in different institutions the humanistic and technical stems of college training, which, in his opinion, were better carried on concurrently in a single, well-coordinated program. He said that the activities of those individuals who were promoting in the New York State Legislature a bill which would lead to a required program of preengineering in the liberal arts should be of grave concern to engineering educators. Under such a statute, he continued, flexibility and experimentation in engineering curricula would be impossible. In his opinion the soundness of the legislative proposals to acculturate the engineer of the future might be questioned. Engineering educators, he said, should be left free to solve their own problems.

R. C. Muir, vice-president in charge of engineering of the General Electric Company, Schenectady, N. Y., said that the professional status of the engineer would not be enhanced by engineers' telling one another and the public that the standing of the profession in society was not what it should be. A look at the record, he said, should fill engineers with pride. He then outlined briefly how the General Electric Company feeds the engineering graduate into its organization, and he concluded by saying: "Engineering is a grand profession, and I am proud to be a member of it."

BY-PRODUCTS OF E.C.P.D.

Review of D. C. Jackson's Report on the Present Status and Trends in Engineering Education in the United States

NO ONE can justly accuse engineering education of lack of vitality or of needing the restless spirit of self-inquiry that is a foe to smugness and mediocrity. This is not to deny that smugness and mediocrity exist in engineering education as indeed they do in all of the large affairs of men. They are present chiefly in the backwaters of the profession. The strong forward surge of the main stream sweeps along with it men and institutions of lesser ambition and ability. Nor is the reason hard to find. Engineering itself is restless and is based on an overpowering urge for improvement. It is successful only when its practices and accomplishments are free from mediocrity. It must lie close to truth and natural law or it ceases to be, and it shares that dominant quality of nature itself, the dynamic, evolutionary principle.

Engineering education owes its vitality and success to the efforts and wisdom of great men, men who have met with success not only in conducting engineering works but also in embodying the methods and knowledge of their art into educational techniques, and in deriving from the sciences those powerful aids to human understanding and accomplishment that determine the course of man's material advancement. For years a stepchild of the university, the engineering school, under the influence of such men and with the enrichment derived from contacts with science and engineering practice, has fought its way upward and stands today on the level of the university, if, indeed, it does not, in some cases, stand on a higher level.

Not the least of the directive influences that have guided engineering education in recent years has been the attitude of mind that has forced the more representative portion of its leaders and teachers to participate in research and engineering practice, to attempt an integration of education, the profession, and the industries, and to turn the searchlight of honest inquiry on objectives, methods, institutions, and men in an endeavor to raise standards and improve quality. Greater academic detachment than has been the rule would have placed on industry a heavier burden of responsibility for training recruits than it now bears. It might have failed to maintain the constantly shifting balance between science and empiricism to which enrichment by theory and fertilization by practice contribute. A dangerously sheltered environment might have encouraged indifference to opportunity and stifled inquiry. To none of these dangers has engineering education succumbed; and although room for improvement still exists, as Dr. D. C. Jackson points out in his report on engineering education,[1] the majority of engineering schools "are now in a sound status and are wide-awake to improve their effectiveness."

JACKSON REPORT A BY-PRODUCT OF ACCREDITING

The report under review is one of the valuable by-products of the task of accrediting curricula in engineering that has been accomplished with such notable success during the last few years by the Committee on Engineering Schools of the Engineers' Council for Professional Development. Although the work of this committee provided the data and the opportunity for studying them critically, as well as the initiative for undertaking the study, the report itself is destined to go down in history as the "Jackson Report." There is good precedent for this. Previous noteworthy reports on engineering education, regardless of the auspices under which they were prepared, are associated with the names of the men chiefly responsible for their significant quality. There is the Mann report, the Wickenden report, the Potter report, all of which Dr. Jackson reviews as the background against which the E.C.P.D. played its role and as the points of reference with which comparisons are made of the status and trends to be noted today. All of these reports have been fruitful influences in the enrichment and progress of engineering education. In every case, although some specific organization made the studies possible and although hundreds of persons contributed to the data, one man has performed the major portion of the task of analysis and interpretation. Indeed, it is to be doubted if a better method could be devised. The data on which all of these reports are based are available for anyone to study. Had the reports been committee pronouncements, it is safe to say that differences of opinion that are bound to exist among committee members would have resulted in compromise and perhaps colorless observations. With either alternative engineers and educators would have missed the keen penetration and thoughtful comments of a man who is endowed with natural gifts of analysis and is familiar with the progress of engineering education.

Dr. Jackson's report may be divided roughly into four parts to which an appendix has been provided by Allen W. Horton, Jr., who acted as secretary to the committee during the period in which the accrediting procedure was developed and put to the test and the data were collected. In the early chapters of the report Dr. Jackson traces the history of developments that led up to the accrediting program, summarizes the well-known Mann, Wickenden, and Potter reports that have played important roles in that development, and sketches briefly the status of engineering education in America in 1939. He next turns his attention to the Committee on Engineering Schools of E.C.P.D., to the procedure it adopted in its task of accrediting curricula, and to comments on some of the perplexing problems it had to face and the progress of the committee's own thinking and methods that resulted from actually coming to grips with these problems.

The data themselves, which cover 679 curricula in 139 institutions, assembled, coordinated, and analyzed in the form of tables and charts, with Dr. Jackson's comments on what they signify to him, occupy the third portion of the report. These data were gathered for the purposes of the accrediting program, which they usefully served, but their very existence constituted such a rich store of information of value to engineers and educators and were so fruitful for the improvement of engineering education, that the committee was able to secure from the Carnegie Foundation for the Advancement of Teaching the funds necessary to put them in shape for public use.

The final portion of Dr. Jackson's report is a masterful chapter on present trends in engineering education. If no other portion of the report is read by engineers and educators, this chapter should be, for here is the considered view of a man who

[1] Report on "Present Status and Trends in Engineering Education in the United States," by D. C. Jackson, with an appendix by Allen W. Horton, Jr. Published by the Engineers' Council for Professional Development, New York, N. Y., 177 pp., tables, charts, 1939.

has spent his lifetime in engineering practice and education and who has studied the data used in the accrediting program.

Mr. Horton's contribution, an appendix to the report, is a history of the Committee on Engineering Schools and a digest of its minutes, which shed much light on problems and procedure. In it there is brief mention of the two most important by-products of the committee's work, the advisory service in which members of the committee found themselves engaged when administrators of engineering schools realized that this group of men had acquired an unusually clear understanding of institutions and curricula, and the study of status and trends that resulted in the Jackson report.

Facsimiles of the original questionnaires used by the Committee on Engineering Schools constitute a second appendix.

For the purposes of this review, attention will be directed to what Dr. Jackson has to say about status and trends, and, in a very superficial way, to the bases on which the data were analyzed. It is assumed that the reader is familiar with the E.C.P.D. program of accrediting curricula of engineering schools and the procedure by which it was carried out, and hence no reference to this phase of the report will be made.

PRESENT STATUS OF ENGINEERING EDUCATION

As to present status, Dr. Jackson provides a convenient summary in the following passages quoted from the report:

It is reasonable to say that the majority of the substantially one hundred and sixty engineering schools in the United States are now in a sound status and are wide-awake to improve their effectiveness. The principal defects in the quality of faculties are perhaps a lack of recognition of the unity of learning in science and in political economy as applied in engineering, an inadequate espousal of professional ideals as distinguished from either craftsmanship or speculative philosophy, a failure to impress on all students that a successful engineer's life demands continuous study throughout its length, and a failure to dovetail the curricula into political economy on one side as thoroughly as they are dovetailed into physical science on the other side .... Part of the onus for the defects named may be appropriately laid at the doors of administrative officers. .... There is an additional fault. .... which is the failure to recognize that the proper use of research vitalizes all levels of engineering education, from the sophomore undergraduate level to the most advanced levels, which makes it a requisite and important factor in such education.

There are some critics who sigh over the state of engineering education and propose forcing modifications of its processes or of its duration by legislation in the states. They, however, usually visualize only some one of the aspects of engineering practice (such, for example, as independent practice as a consultant), and they would make preparation for all the varied characteristics of engineering by means of one mold. Such proposals are false to the needs of the nation and its industries. The proponents sometimes argue from apparent analogies with the professions of medicine and law, but fail to yield thought to the vast difference in the scope of engineering activities compared with medicine and law, and therefore the wider variety of education that should be available without regimentation for practitioners in the various aspects of engineering. The evolution of engineering education over a variety or range of undergraduate and graduate curricula has occurred to meet the needs of the nation, and evolutionary changes are constantly under way as the needs of the nation's population and its industries change and the enlarging disclosures from scientific research make practicable. If the existing lag between the precepts and the fittingness of economic tenets, the vision of social relations and the ethics of political science can be overcome, the rate of evolution referred to will be accelerated naturally, but this cannot now be foreseen with definiteness. . . . . .

According to the questionnaries, of the 135 engineering schools which were acted upon by the E.C.P.D. up to October 22, 1938, there were a total of some 3832 persons in the teaching staffs of the engineering departments of the engineering schools in the years between 1933 and 1936. These schools reported a capital investment for buildings and equipment of $137,835,000 apportioned to engineering, and an annual income allotted to engineering of $23,870,000. The foregoing investment was $2060 per student and the income for engineering was $358 per student per year, including all students (i.e., both full-time and part-time students).

FACTUAL DATA ARE CHARTED AND TABULATED

For the chapter on tables and charts, Dr. Jackson explains how the engineering schools were divided into three categories called "high," "medium," and "nul."

"If *seventy-five per cent* or more of its curricula have been accredited, an institution is placed for statistical purposes in the category *High*. If *one or more curricula* have been accredited but the number is *less than seventy-five per cent* of those in the program of the institution, the institution is placed in the category *Medium*. Finally, if *no curriculum* has been accredited among those submitted, the institution is placed in the category *Nul*."

Other categories used in tabulating and charting the data were made up on the basis of seven geographical regions (New England, Middle Atlantic, North Central, South Eastern, South Central, South Western, and North Western states) and of eight types of institutions (privately endowed universities, state universities, municipal universities, privately endowed polytechnic institutes, state polytechnic institutes, state colleges of engineering and agriculture, privately endowed colleges, and military colleges).

The 13 tables and 22 charts are arranged for factually exhibiting the following features digested from the questionnaires:

1 The distribution of engineering schools by categories, by geographical regions, and by types of support.

2 Financial features, including faculty salaries, instructional cost indexes, annual incomes, values of facilities.

3 Ratios which bear on quality of instruction, including laboratory areas per student, students per instructor.

4 Qualifications of faculties, including education, experience, inbreeding, relative distinction. Here the questionnaires are supplemented by other data.

5 Distribution of subject groups in curricula of civil engineering, electrical engineering, and mechanical engineering, and recent changes.

It is obviously impossible to present a résumé of what these charts and tables reveal and what conclusions may be drawn from them. Dr. Jackson has done this in what appears to be a spirit of wisdom and fairness. Generalizations by this reviewer in the space available would probably be neither wise nor fair. An attempt will be made, however, to summarize briefly what Dr. Jackson has to say about present trends.

TRENDS IN ENGINEERING EDUCATION

Dr. Jackson notes as the first trend in engineering education the desire on the part of engineering teachers to formulate true definitions of objectives for engineering education. Second, he notes influences tending to vitalize engineering education as the result of the willingness of engineering teachers to scrutinize and favorably discuss affirmative attitudes toward certain questions relating to their responsibilities that were "coldly received" a decade ago. Next come "the widely spreading recognition of the need for improved pedagogical methods" and "the fuller acceptance, as a tenet, of the significance of research for the education of engineering students while in the upper years of their undergraduate careers." "The criteria applied in selecting and promoting staff appointees," he says, "are in a badly mixed trend."

With respect to students, Dr. Jackson comments on trends in selection and selective methods, "more steadfastly and judiciously" dispensed financial aid, "honors seminars in junior and senior year," association with teachers in laboratory work of a research character, slowly widening interest in "examinations of truly comprehensive character" and the "reduced

emphasis on term examinations in individual subjects," and more stimulating textbooks.

There is, he points out, increasing interest in student meetings of the national engineering societies and a "tendency to carry on experiments in education and research in which more than one department takes an active interest." An impressive trend lies in the recently developed attention to the social relations of engineering and the social responsibilities of engineers, coupled with a swing from "practical empiricism to sound science." The change in attitude toward instruction in English "has been almost revolutionary," and there appears to be some evidence of a return to the study of foreign languages. The importance of economics and sociology "as subjects for close and accurate study by engineering students" is noted and discussed by Dr. Jackson.

Dr. Jackson finds a trend "forward and upward" in junior colleges and comments on the effects of this trend on engineering schools. Trends in curricula are pointed out and the statement is made that "the tendency of engineers unqualifiedly to denominate the curricula of engineering schools as illiberal or overspecialized is not well-founded." The trend toward graduate study, he says, has been encouraged and is worthy of such encouragement. Questions of the number and content of curricula, of electives, and of transfer are discussed, and trends toward establishment of "experimental curricula" or "newly defined experimental subjects of instruction" are noted, as are those relating to evening and cooperative courses.

A need exists, says Dr. Jackson, for the "formulation of a broad but convincing definition of the purposes of engineering education." The increasing recognition of research as a factor in engineering education comes in for favorable notice, as does also the "awakening of executive officers to a recognition of the professional character of engineering education," a recognition which is also being shared by the public.

No appreciable change is noted by Dr. Jackson in the sources from which engineering teachers are recruited, and the securing of the right kind of teachers is still a major problem. A desirable trend is the "wider adoption of reasonable retirement and pension policies." Selection of new staff members still seems to rest unduly heavily on academic degrees. The depression has served to decrease the flow of younger staff members into industry, thus reducing turnover. There is a trend toward bringing research from a backward position with respect to teaching and practice.

The list of trends is completed with observations on "institutional jealousies" which are said to be "softening" and are being replaced by cooperation and the elimination of duplication of men and equipment. "Ultimately," Dr. Jackson observes, "the engineering schools may reclassify themselves on segments determined by the ability (with their several locations and financial means) to minister best to students of various ambitions," thus laying the foundation for elimination of duplications and concentrating different work where it can best be dealt with. "Unhappily," he continues, "a trend now exists which disturbs the balance instead of improving it. This is the tendency of Technical Institutes to change into the scope of degree-granting engineering schools. The need in the engineering field is not for fewer students in the aggregate of those who are preparing for higher engineering work plus those who are preparing for the engineering trades; but the need is for better-sifted engineering students in the engineering schools and an increased proportion of Technical-Institute students looking forward to the engineering trades. The tendency referred to is in the opposite direction from the needs. Its strength is increased by the manner of administering engineer-licensing laws of several states, by which engineering-school graduates are credited with an equivalent of practice on account of their degrees while those without degrees do not secure such credits for their studies. This trend is causing more unbalance than ever of our already unbalanced educational provisions in the technical field. No means have been proposed for offsetting this unfortunate situation. A correct trend would be to increase the number and excellence of Technical Institutes for training competent technicians in all industrial divisions of the country."

These fragmentary portions of a comprehensive and penetrating survey of trends do small justice to Dr. Jackson's report. If they have aroused in the reader a desire to study the entire report, which may be purchased from E.C.P.D., they will have served their purpose.—G. A. S.

Cushing

THE SKYLINE OF THE DOWNTOWN BUSINESS SECTION OF PHILADELPHIA

(Viewed down the parkway, centering on City Hall, with the camera planted on the steps of the Art Museum. For last-minute news concerning the Sixtieth Annual Meeting of The American Society of Mechanical Engineers to be held in Philadelphia, Pa., Dec. 4 to 8, 1939, see pages 931-933 of this issue.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

UNDOUBTEDLY the biggest news of the last month was the approval by the Congress on November 3 of the Neutrality Resolution which repealed arms embargo and substituted cash-and-carry regulations. Passage of the resolution was a conspicuous example of the functioning of a democracy in an emergency. On a question on which widely divergent views were held, and in which the entire country had a lively interest, a decision was reached without serious public dissension following a debate in which both sides respected one another for the sincerity of their opinions. A common determination to keep this country out of war prevailed; arguments concerned the probable effect of the policies to be adopted to that end. One sector of public suspicion was quieted by numerous pronouncements of manufacturers and businessmen to the effect that war was abhorrent to them and unprofitable in the long run. If this country has learned any sound lesson during the last quarter century it has been to suspect wars and booms.

Immediate effect of the steps the President took as a result of the changed neutrality law will touch closely the lives of many engineers. Shipments of aircraft, held up because of the restrictions of the law before repeal of its embargo provisions, will be made, but not in American ships. Aircraft factories and whatever industries supply them will have plenty of new business. The manufacture of munitions can also be stepped up for the same reason.

On the other hand, curtailment of American shipping on routes that enter the combat areas will call for many readjustments. It is said that approximately 30 per cent of the American vessels in foreign trade, something more than 90 ships, will have to be withdrawn, and that eight foreign-trade routes must be abandoned, unless some plans, such as change of registry, can be worked out under the new rules to permit their employment. What other corollary effects the new neutrality resolution will have remains to be seen; obviously many readjustments in trade and industry are indicated and engineers cannot avoid being among those directly affected.

On the Four Fronts

In Europe the progress of the war is marked by four factors that have given rise to the designation, "a phoney war." First there is the diplomatic front on which anything can happen. It is veiled in secrecy, false reports, hidden motives, and astounding inconsistencies.

Second, is the propaganda front. The effectiveness of propaganda attack is unpredictable; even the stoutest patriot finds difficulty in dealing with "psychology," his own or others. Cities captured, shipping destroyed, and casualties can be measured in quantitative terms, but who can assess the effects on the human mind of words, true and false, of the interruption of normal pursuits, of overdoing and underdoing attempts to influence thought? The radio has enormously increased uncertainty on the propaganda front.

Third, there is the blockade, with the attacks and defenses both sides undertake in the air, on the surface, and below the surface of the water. The blockade and its incidents provide today the most active news. Its most serious effects, privation and broken morale, are not immediately felt.

Finally, there is the apparent stalemate in Western Europe where huge concentrations of men and military equipment stretch along Germany's border. Here time fights on the side of the Allies. While time holds the military front stalemated, it assists decisions on the other fronts; in diplomacy, from which objectives and realignments, and even serious discussion of peace terms, may emerge; in propaganda, where it allows ideas to germinate; and in the blockade, where it is assisted by economic disintegration.

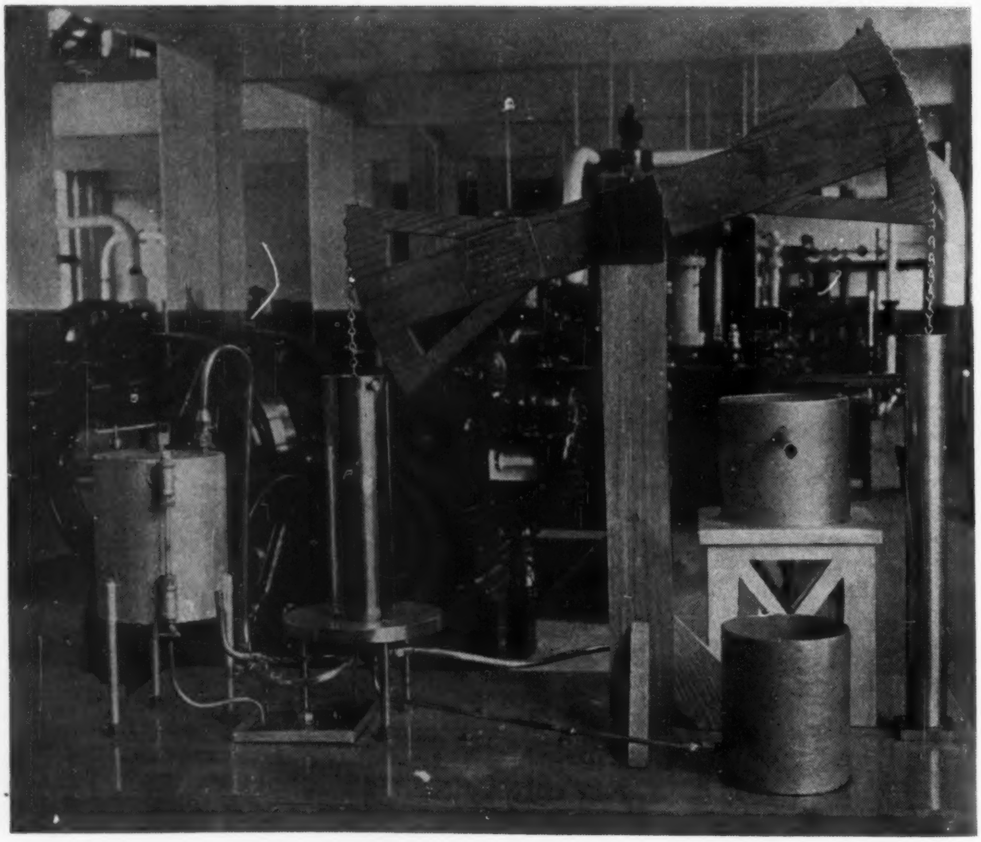
Domestic Issues

With the arms embargo repealed and until incidents develop to focus public attention on the actual results of the changed national policy, opportunity is afforded for domestic issues to get into the headlines once more. With all of the protests of men in the public eye to the effect that their concern is not with Europe but with the United States, submergence cannot be long continued of such issues as unemployment, modification of the wages and hours law and the Wagner Act, strikes, in which the technique of the slowdown has been used, the national debt, found to be in excess of 40 billions at a time when extraordinary expenditures for the national defense are urgent, and national unity based on mutual confidence and respect of industrial, commercial, and agricultural regions, and on cooperation between government and business.

Business indexes steadily mounting upward have brought mixed feelings in which hope that the revival is sound and that it will not peter out or get out of hand, are offset by fears of a war boom with inflation and overexpansion of production facilities and prediction that the spring will witness a slowing up and further discouraging delays in the nation's attempt to rebuild its economy on a sound basis.

Evidence is accumulating that labor troubles will force action to modify some of the social legislation passed during the present Administration. Even honest zeal overreaches itself. It was to be expected that labor would take advantage of the legislation written in its favor and administered by men sympathetic with its views. What spoiled a promising experiment in industrial relations was an unmannerly and bitter feud within the ranks of labor over the control of labor unions in which the public in general have been the long-suffering victims.

The Chrysler "dispute" is estimated to cost \$3,000,000 a day. Regardless of whether this figure is too high or too low, the evidence is clear that a few determined men can disrupt normal



A SCALE MODEL OF THOMAS NEWCOMEN'S ATMOSPHERIC ENGINE, USED IN ENGLAND FROM 1712 TO 1775, PRESENTED BY THE AMERICAN BRANCH OF THE NEWCOMEN SOCIETY TO THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

(The model, a gift of the New England members of the society, was built at Lehigh University and is a duplicate of one constructed for the Watt Centenary in 1936. The model is shown in the Institute's steam laboratory.)

business over a wide geographic and economic area, and bring hardship and disappointment to thousands of helpless innocents. There is, of course, nothing new in this fundamental fact; it has been a fact since the first attempts of men to set up social orders in tribes and villages. The tragedy of it lies in the slow progress man has made in the intelligent administration of his social life. Optimists can hope that out of present turmoil better ways of life will evolve. More than optimism is needed to assure a desirable direction for this evolution, however; and here further application of organized intelligence, typical of engineering methods, would greatly help.

Automobile Show

It is characteristic of men to desire security, comfort, and greater values at a lesser price. In themselves these ends are worthy; the trouble comes through the ways by which men attempt to seek them. One way is the road of conquest that has run through all history. Those who follow it do so at the expense of their fellow men. In Europe and Asia today this road leads to war. In this country it leads to industrial strife and to schemes for taking from the "haves" and delivering to the "have nots." It is a road that runs but never arrives.

A better road is the way of organized intelligence working through the methods of science and engineering. Here there is no conquest, except of ignorance, scarcity, despair, and natural hazards. Destruction is replaced by production; division and confiscation of the fruits of labor by opportunity for self-support. What men desire may be found at the wayside, not in some hoped-for haven at the end.

A conspicuous example of how safety, comfort, and greater value have been achieved by following the second rather than the first of the foregoing routes was observed at the automobile show. The automobile industry has not provided these qualities in its product by taking away what some had and giving it to others, but by giving more to everybody. It has done this by the intelligent application of science and human skills to a productive process within a commercially highly competitive field.

Consider safety. Hazards of automobile travel have been met by the automobile industry not by legalistic and defeatist measures but by earnest attention to the hazards themselves. The danger of blinding headlights was not combated by providing less illumination but by using more in an intelligent manner. Instead of campaigning for lower legal speed limits or of placing speed governors on engines to curb the reckless driver, more effective brakes were designed, stronger bodies were built, and steel replaced wood and fabric in construction. Shatterproof glass, which has made it possible to maintain high standards of comfort and visibility with greater safety, was a development of the methods of science and engineering in the realm of new and "synthetic" materials. It was not based on coercion or the restriction of individual privilege.

In the realm of comfort the record too is conspicuous. Here again solutions have been found without sacrifice of other desirable features and in a progressive spirit. Windshields and enclosed body structures, improved riding qualities, heating and ventilation requirements have taxed the ingenuity of engineers rather than the income of property holders. The steady progress from self-starter to "automatic" transmission has gone forward without social legislation or federal subsidy to effect it. A few years ago it was a triumph merely to keep four wheels turning without aid of horse or gravity. Today many autoists are more comfortably housed in their cars than in their homes. The radio goes with them lest in the solitude of nature they lose touch with their fellow men. Tomorrow the atmosphere of their traveling vehicles will not change with the rigors and ardors of the countryside but will be conditioned to their personal whims. Greater safety and comfort

in the automobile are not the largess of vote-seeking politicians or crusading demagogues paid for out of the public purse. They are products of the engineer's method which aims to distribute what it creates, and not what others have created.

As to value the method has also proved its effectiveness. Only by the exercise of organized intelligence can greater real value be offered year after year without increases in price. Price in the automobile industry is recognized as a quantity determined by external factors; competitive conditions constantly demand greater value; hence costs must be lowered. The difference between "cost plus profit equals price" and "price minus profit equals cost" is typical of the difference between the old and the new methods and holds the solution of the problem of retaining both profit and progress. Engineers like to think that their technique has made it possible to reduce costs, raise wages, and make a better product and some profit without increasing prices to a point that kills sales. Extension of the technique to many other fields might bring desirable results.

Thus, if we choose to see it, there is in the automobile show a demonstration of a better way of satisfying human desire for security, comfort, and greater value than has ever been found in the destructive method of conquest, division, and diversion. Whether the aim is "lebensraum" or "thirty dollars every Thursday," the method of organized intelligence operating in a world of growing scientific knowledge is a better way. It proved the predictions of Malthus to be wrong a century ago; it will do so again. And it will preserve and nurture the qualities of man by which he has advanced instead of weakening them as the method of "ham'n'eggers" threatens to do.

Engineering Education

Two announcements in the field of engineering education were made during the last month; the appointment of Kenneth H. Condit to succeed Arthur M. Greene, Jr., who retires at the end of the present academic year, as dean of the Princeton School of Engineering, and the consolidation of Armour and Lewis Institutes, in Chicago, to form the Illinois Institute of Technology.

Dean Greene retires from a long career in engineering education spent at Drexel Institute, the University of Pennsylvania, the University of Missouri, Renssalaer, and Princeton. He is well known for the textbooks he has written, for his services to engineering societies, notably The American Society of Mechanical Engineers, and for his professional work in engineering practice. Retirement from active administration at Princeton will, his friends hope, permit him opportunity to continue his work in engineering societies and in the betterment of the engineering profession, fields in which wise counsel is particularly needed at present.

Mr. Condit is no stranger at Princeton. He is a graduate of that institution, and before he entered upon his career as editor of the *American Machinist* he taught for some years on its faculty. For several years he has been active on a committee that has been studying the needs of the school. He is well known in engineering and industrial circles because of his editorship of the *American Machinist* and the position with the National Industrial Conference Board which he now holds, as well as his active services to The American Society of Mechanical Engineers. He is at present a vice-president of the Society. The opportunity Mr. Condit faces at Princeton calls for the combination of experience and personal qualities that he brings to the task. Engineering education is in one of those states of flux that determine its future course. Conditions call for men who understand both educational and the industrial opportunities, obligations, and limitations. The marked trend toward "liberalization" of engineering education, for concentration of effort on men of high promise, and for extension of graduate study is particularly adaptable to schools of engineering operated within the pattern of privately endowed universities. Mr. Condit may be depended upon to guide this trend at Princeton with wisdom and energy.

The task of consolidating two engineering schools in Chicago is of major proportions. A new physical plant must eventually be constructed on a new campus on the basis of an undergraduate enrollment of 7000 students in engineering courses. The opportunity is commensurate with the task. Every metropolitan area presents demands on its educational facilities that multiply at a surprising rate. Modern standards make it necessary to provide engineering education to young men headed for important positions in industry and enterprises where the benefits of this type of training may be usefully employed. Greater service to the community and the nation, as well as to youth, should result from the combination of these two institutions into a single organization.

LaGuardia Field

On Sunday, October 15, in the presence of several hundred thousand persons, New York Municipal Airport at North Beach, Long Island, on Bowery and Flushing Bays, directly opposite the Bronx and between the recently completed Whitestone and Triboro bridges, which give easy access to Westchester County and New England over the former and Manhattan over the latter, was officially dedicated. This forty-million-dollar project is designed to serve land and sea planes alike. It covers an area of 550 acres and its four runways are 6000, 5000, 4500, and 3532 ft long, respectively. Six huge hangars for landplanes and one for seaplanes, together with a terminal building for each type of service and other structures are of impressive size and architecture. Using the new airport, which, at the suggestion of the Board of Estimate, has been renamed by John McKenzie, Commissioner Department of Docks, as New York Municipal Airport, LaGuardia Field, in honor of the Mayor, will be a number of airlines. A paper describing certain engineering features of the new airport will be presented at the A.S.M.E. Annual Meeting, Philadelphia, Pa., Dec. 4–8, 1939, by Samuel E. Stott, chief engineer, design section, Operations Division, Works Progress Administration, New York City.

Honored

On November 14, at The Franklin Institute of the State of Pennsylvania, the first award of the Vermilye medal was presented to Lewis H. Brown, president of the Johns-Manville Corporation, New York, N. Y., "in recognition of outstanding contribution in the field of industrial management." This is the first award of the medal which is named after its donor, William M. Vermilye, vice-president of The National City Bank of New York. R. A. Wentworth is the A.S.M.E. representative on the Vermilye Medal Advisory Board.

In Washington, on October 19, following the announcement on October 7 of the resignation as its chairman of Dr. Joseph S. Ames, the National Advisory Committee for Aeronautics passed a testimonial resolution commemorating his 20 years of service. The testimonial, which was presented to Dr. Ames on October 23 by a special committee consisting of Vannevar Bush, Lyman J. Briggs, Edward P. Warner, George W. Lewis, and John F. Victory, read in part:

DR. JOSEPH S. AMES

When aeronautical science was struggling to discover its fundamentals, his was the vision that saw the need for novel research facilities and organized and sustained prosecution of scientific laboratory research. His was the professional courage that led the Committee along new scientific paths to important discoveries and contributions to progress that have placed the United States in the forefront of progressive nations in the development of aeronautics. His was the executive ability and farsighted policy of public service that, without seeking credit for himself or for the Committee, developed a research organization that holds the confidence of the governmental and industrial agencies concerned and commands the respect of the aeronautical world. Withal, Dr. Ames was an inspiring leader of men and a man beloved by all his colleagues because of his rare personal qualities.

Carl Barth

Chance has closely linked the death of Carl G. Barth with the publication by the A.S.M.E. of the "Manual on Cutting of Metals." Carl Barth is best remembered because of his association with Frederick W. Taylor, and the Manual is not only a modern extension of Taylor's work on the art of cutting metals but a tribute to his pioneering genius as well. It was Barth who helped Taylor in the mathematical presentation of his data and who was long famous for the slide rules he devised for the use of shop men in applying Taylor's work.

For years Barth was a familiar and picturesque figure at A.S.M.E. meetings, enlivening any session at which he was present by his vigorous and colorful discussion and verbal encounters. Small and frail in body, his mind made up in its vigor what his physique lacked. To those who saw and heard him for the first time he appeared testy and contentious, yet none could hear him without gaining respect for his opinions. Older members of the A.S.M.E. will recall how he used to warn the stenographer at meetings of the Society not to record his remarks. It was a useless warning because his rapid-fire delivery and his Scandinavian brogue were hard for a non-engineer to follow. The explosiveness of his manner, particularly in debating a controversial point, added zest and interest to the meeting and endeared him to many phlegmatic persons. He had a rare gift of being able to use mathematics as a common tool, and was a pioneer in its application to many machine-shop uses. He will linger long in memory for the vividness of the impression he made wherever he appeared.

Rubber-Tire Clutch

AUTOMOBILE ENGINEER

A NEW TYPE of clutch has been developed by an American rubber manufacturer in which the torque is transmitted by a flexible, inflatable rubber tube resembling an automobile rubber tire. With the driving and driven elements arranged coaxially, one within the other, the rubber tube may be attached to either element. When distended by inflation the tread portion of the tube is brought into driving contact with the clutch surface and in its deflated condition collapses to clear it. Owing to the resilient nature of the tube, the operation of the clutch is unaffected by annular or axial misalignment and effective driving connection is maintained despite lateral or longitudinal relative movement of the shafts.

As described in the October, 1939, issue of *Automobile Engineer,* and illustrated in Fig. 1, the driving member is a drum-type flywheel *A* attached to the shaft of an internal-combustion engine which, incidentally, may be flexibly mounted on rubber supporting blocks *B*. Splined on the end of the driven shaft *C* is a hub to which is riveted a wheel *D* to carry the tube *E*. Constructed like an automobile tire with a radially disposed cord reinforcement, the tube is formed with flexible side walls and the thickened tread is rendered more yieldable by narrow, closely spaced circumferential ribs. The tube may be continous, as a tire, or split and furnished with butt ends as shown at *F* to facilitate removal and replacement. In either case it is vulcanized to a flexible metal base *G*, preferably of brass or bronze, carrying the bolts by which it is attached to the wheel *D*.

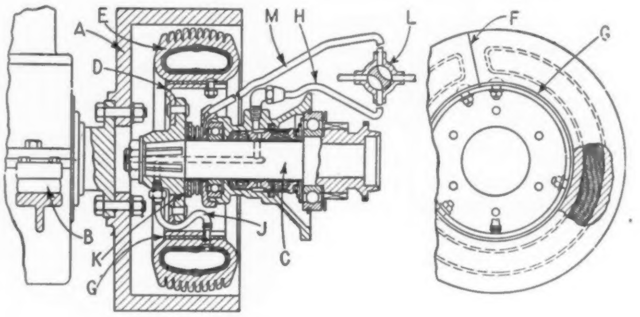


FIG. 1 RUBBER-TIRE TYPE OF CLUTCH

Air is admitted to, or exhausted from, the interior of the tube by way of pipes *H* and *J* and drillings in the shaft *C*. To arrest the motion of the driven shaft when disengaged, a brake disk *K*, mounted on the end of a bellows attached to the forward bearing housing, is operated pneumatically against the rear face of the hub. Control is by a two-way cock *L* which in the position shown exhausts the tube and admits air under pressure to the clutch brake by way of pipe *M*. When the plug of the control cock is turned through 90 deg the connections are reversed to release the brake and inflate the tube to take up the drive.

Lastics

MODERN PLASTICS

FORMULATION of rubber stocks for particular purposes in industry and in our everyday lives is made possible through the proper use of rubber-like materials, or lastics, as they are called by W. L. Semon in an article entitled, "New Elastic Materials Expanding the Field for Rubber," which appears in *Modern Plastics* for October, 1939. He says that these materials are seldom used alone but rather they are used in combination with each other or with rubber. Articles commonly described as being made of synthetic materials, usually are mixtures containing in addition one or more of the following: natural rubber, pigments, oils, plasticizers, resins, antioxidants, accelerators, and vulcanizing agents.

A number of rubbers, substitutes, and synthetic materials available for use, together with their characteristics, are given in Table 1. Only general class names are given but there may be a large number of different varieties in each class. For instance in the case of natural rubber there are dozens of minor varieties available, and in the case of neoprene several lettered varieties having slightly different properties have been offered.

TABLE 1 PROPERTIES OF NATURAL RUBBER AND VARIOUS LASTICS

Material	Chemical Composition	Physical Characteristics of Unvulcanized Material	Vulcanizing Characteristics	Typical Characteristics of Vulcanized Material
Natural rubber	1,4 Linear polymer of isoprene	Very rubbery. Softens at high temperature, freezes at low temperature. Pale color. Slight odor. Chemically resistant.	Vulcanizes with sulfur to become non-thermoplastic.	Very rubbery. High tensile strength, good elongation at break. Rapid recovery after stretching. Resistant to abrasion. Good electrical properties. Not affected by many chemicals or solvents. Excellent rebound elasticity
Buna S	Emulsion copolymer of butadiene and styrene	Rubbery. Does not soften much with heat.	Vulcanizes with sulfur to give very rubbery non-thermoplastic.	Very rubbery. High tensile strength and good elongation at break. Rapid recovery after stretching. Resistant to abrasion. Fairly resistant to heat. Excellent rebound elasticity.
Perbunan	Emulsion copolymer of butadiene and acrylonitrile	Rubbery. Does not soften much with heat.	Vulcanizes with sulfur to become non-thermoplastic.	Rubbery. High tensile strength, good elongation at break. Fair rebound elasticity. Resistant to abrasion. Very slightly swelled by oil. Properties not deteriorated by oil.
Neoprene	Linear polymer of chloroprene	Stiff and slightly rubbery. Softens greatly with heat.	Vulcanizes by heat to become non-thermoplastic.	Rubbery. High tensile strength, good elongation at break. Fair rebound elasticity. Very resistant to oil. Properties not deteriorated by oil. Resists corona, ozone, light.
Vistanex	Linear polymer of isobutylene	Rubbery. Softens at high temperature, does not harden at low temperatures. Colorless. Odorless. Inert chemically.	Cannot be vulcanized.	
Thiokol	Condensation product of aliphatic dihalide and soluble polysulfide	Slightly rubbery. Softens with heat.	Vulcanizes by action of heat and metallic oxides to give somewhat rubbery product still slightly plastic.	Somewhat rubbery. Fair tensile strength, fair elongation at break. Very resistant to oil and aromatic solvents. Resists corona, ozone, light.
Koroseal	Plasticized gamma polyvinyl chloride	Great range of rubbery characteristics. Plastic at high temperature. Colorless. Odorless. Resistant to chemicals and oils.	Not vulcanized.	
Gutta percha or balata	Linear polymer of isoprene; isomer of natural rubber	Tough and horny becoming rubbery at higher temperature finally melting. Good electrical properties.	Can be toughened by vulcanizing with sulfur becoming non-thermoplastic.	Tough, slightly rubbery. Good strength. High elasticity.
Thermoprene	Rubber isomerization product	Horny becoming rubbery; at higher temperature. For stiffening rubber adhering rubber to metal, or as a paint vehicle	Vulcanizes with sulfur to give a hard product like ebonite.	Hard. High strength, low elongation. Useful for stiffening rubber.
Alkyd resin	Glycerol-phthalic acid condensation product.	Oily or plastic resin.	Hardens by heat to give non-thermoplastic resin.	Strong. Tough. Chemically resistant. Good electrical properties.
Polyacrylates	Polymers of various acrylates or methacrylates.	Resinous. Softens at high temperature. Can be molded. Hard. Transparent. Chemically resistant.	Not vulcanized.	
Reclaimed rubber	Replasticized vulcanized rubber	Somewhat rubbery. Improves processing of other rubber.	Vulcanizes with sulfur to become non-thermoplastic.	Rubbery. Fair tensile strength, fair elongation at break. Most useful when used along with rubber.
Factice	Unsaturated vegetable or fish oils vulcanized with sulfur or sulfur chloride.		Already vulcanized in preparation. Non-thermoplastic.	Weak. Crumbly. Used in rubber to improve extrusion characteristics and to maintain form during cure.
Glueglis	Mixture of glue and glycerol	Dead and only slightly rubbery. Typical odor of glue. Affected by water, heat, but not by oil.	Insolubilized by chromates or formaldehyde becoming less thermoplastic.	Slightly rubbery. Used with rubber for deadening it and imparting resistance to oil.

The properties of the general materials range all the way from true rubbers to resins. Almost all are originally thermoplastic, some however will vulcanize by various treatments, and hence are called vulcelastics. No effort has been made to indicate in the table other than the most general and characteristic properties.

The properties of finished rubber articles depend to a large extent upon the skill with which the ingredients are combined, upon the proper engineering and artistic design of the finished article, and upon careful and skillful workmanship. A vast scope of talent is utilized in the manufacture of the dainty overshoe which milady wears or in the sheer raincape which keeps off the rain. Equal skill but along different lines is utilized in the development of rubber hose for use on gasoline pumps, or for rubber-lining the mammoth tanks used in pickling steel in the new continuous-sheet steel mills.

American Superliners

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

IN CONTRAST to the many American achievements in engineering, manufacturing, management, and finance, we have no superliners although our citizens are the greatest and most affluent travelers in the world and spend about $500,000,000 annually in foreign travel, only five per cent of which would sustain two American superliners remuneratively, states George C. Gaede, passenger traffic manager, American Export Lines, Inc., in a paper presented at the annual meeting of The Society of Naval Architects and Marine Engineers, held in New York, Nov. 16–17, 1939. One asks, "Why haven't superliners been built before?" Principally because, prior to the passage of the Merchant Marine Act of 1928, the Merchant Marine Act of 1936, and amendments of 1938, which equalized the construction and operating costs here and abroad, it was impossible to compete successfully and therefore impossible to attract investors.

Upon the instructions of Congress, the United States Maritime Commission made a survey to determine the possibilities of building and operating American superliners. The negative analysis in a few short paragraphs on the superliner subject would indicate that the Commission's advisers were not sufficiently familiar with the subject since, according to Mr. Gaede, an intelligent, painstaking perusal of the facts could not substantiate their conclusions. For example, the survey states that this type of vessel is believed to be economically unsound. The performance of the *Queen Mary*, a ship of British registry, during a depression period, disproves this. Other reasons given are excessive investment, extreme variations in seasonal business, speedy obsolescence, and the fact that the building of superliners at the expense of more economical ships cannot be justified by the United States. A further comment is that there is little advantage in spending enormous sums on one great ship. The author claims that the great ship is more profitable than the smaller ones and that, as a matter of fact, two superliners will produce more revenue than fifty $2,500,000 freight ships.

The building of American superliners would be a creative job, based entirely on a new set of factor for the moment that an American ship enters the North Atlantic trade, the whole mosaic of past performance would be altered. In building any superliner it is presupposed that the construction and operating costs will be equalized and this fact is now generally recognized in this country. Such a superliner should have a capacity of about 2500, divided into 800 cabin, 800 tourist, and 900

third-class, with a certain amount of space in tourist and third-class designed and equipped to be interchangeable to provide flexibility according to the movement in each class. The size of the vessel would be somewhat larger than the *Queen Mary* to provide for 425 more passengers.

The advantage in American superliners lies in the fact that they could go through to Hamburg and thus participate in the traffic beyond the Channel ports in a two-week turn-around. In this case, the route would be Cherbourg, Southampton, and Hamburg. With increased cost of larger passenger vessels, the operating costs per day for depreciation, insurance, crew's wages, and subsistence, which are constant whether the vessels move or are in dock, the importance of quick turn-arounds is obvious.

The real cost of operating a vessel depends on the number of days that it is moving, and that cost must absorb and must include the expenses accruing during the unproductive period in port. The more the port time is reduced, the greater the number of revenue-producing days. With improved engine design and economical fuel consumption, the author believes that two 35-knot ships are practical and that such ships could maintain two-week schedules.

Engineers say that superliners of this character can be built for about $60,000,000 each, or $120,000,000 for two, including interest during the construction period. Assuming that the government will allow a construction differential of 50 per cent, so that the cost to the operator will be $30,000,000 for each ship, of which he pays 25 per cent, or $7,500,000 for each ship. On top of this, $2,500,000 working capital for the two ships will be required initially, making the total investment to the operator $17,500,000 per vessel.

Taking the same rates as the *Queen Mary*, that is, $325 per head for cabin passengers, $150 for tourist, and $105 for third-class, and using a basis of 22 round trips for each of the two superliners, the annual revenue per vessel, on a 60 per cent capacity basis, would be $12,526,800, and, on a 50 per cent capacity basis, $10,439,000. Miscellaneous revenue, such as mail, freight, bar sales, and excess baggage, would bring these figures to $14,026,800 on the 60 per cent basis, and $11,849,000 on the 50 per cent basis. Annual expenses for each vessel would be made up of the items in Table 2.

TABLE 2 ANNUAL EXPENSE

Item	60 Per cent capacity	50 Per cent capacity
Vessel expense		
Wages	$1,584,000	$1,488,000
Fuel	2,090,000	2,090,000
Lubricating oil	7,700	7,700
Water	11,000	11,000
Subsistence, crew and passengers	909,370	788,225
Repairs	540,000	540,000
Stores and equipment	572,000	551,000
Insurance	675,000	675,000
Other expense	12,000	12,000
	6,401,070	6,162,925
Port expense	925,800	925,800
Cargo expense	234,000	219,000
Brokerage	637,340	531,340
Other voyage expense	350,000	325,000
Total vessel and voyage expense	8,548,610	8,164,065
Gross profit available from direct operation	5,478,190	3,684,935
Less depreciation at 5% on $30,000,000	1,500,000	1,500,000
	3,978,190	2,184,935
Less: Interest at $3^1/_2$% on $22,500,000 government loan	787,500	787,500
General administrative expense	1,402,680	1,184,900
	1,788,010	212,535
Add operating subsidy	1,773,750	1,697,000
Less amortization requirements	1,125,000	1,125,000
Surplus before dividends and taxes	$2,436,760	$ 784,535

This result is achieved without consideration of the profits accruing through the investment of the depreciation fund and surplus profits over dividend requirements. On a 60 per cent capacity basis, the government would recapture $68,550,281 for both vessels, or $8,550,281 more than the construction differential of $60,000,000 allowed; the government mortgage of $45,000,000 would be liquidated in about five years; and the cost to the government in total subsidy would be $3,119,986 per annum. On the 50 per cent capacity basis, the government would recapture $33,995,818 of the $60,000,000 construction differential; the government mortgage loan of $45,000,000 would be entirely liquidated in about eight years; and the cost of the subsidy would be $4,694,209. Both these calculations are on the basis of only forty-four weeks' Atlantic service operations and do not include cruise employment, which would add net profits from $375,000 to $500,000 per year for each vessel.

The Many Uses of Mercury

RESEARCH AND INVENTION

MERCURY, known as "live silver" or "quicksilver" to ancient peoples, is still one of the most important metals in our times. As told in an article in the September, 1939, issue of *Research and Invention*, a publication of The Ohio State University Research Foundation, the United States, with private instead of government control of deposits, has the largest number of mercury mines, mostly in California, Texas, and Oregon, and ranks next after Italy (and Spain when it is in the running) as a producer, furnishing half of our requirements. Mercury is bought and sold by the flask of 76 lb, and yearly we use about 30,000 flasks. Mercury prices have fluctuated widely since they fell from around $120 a flask before the depression to the present price of $90, with some tendency to rise because of the European war.

As an out-and-out war material, mercury is used as a detonating agent, in the form of mercury fulminate, invented in 1799. Before that time muskets were fired with the famous flint and steel. To make fulminate, mercury is treated with nitric acid and alcohol. In various combinations it goes into all sorts of percussion caps. Some other unstable compounds explode violently enough to be used as detonators, but despite substitutions mercury fulminate remains very important in this war business. Of course detonators are not used solely for war. Industry requires quantities of blasting caps for all sorts of excavation, tunneling, and quarrying work.

Mercury's use as a fulminate is spectacular, but in many respects its quieter roles are more important. Mercury in industry touches our daily lives at many unsuspected points. One of the most recent developments, with which mechanical engineers are familiar, is the mercury boiler. Of course, once the mercury boilers are installed, very little additional mercury is required for replacement.

The thermometer is another example of mercury's use; a small amount, but extremely important. It is used for all kinds of laboratory apparatus: Barometers, compensating pendulums, gages, meters, switches, pumps to produce high vacua, and thermostats. A metal which is very heavy, liquid at ordinary temperatures, uniform in heat expansion, slow to oxidize, and a good electrical conductor seems almost too good to be true in the laboratory.

Industry, medicine, and the arts require a host of mercury compounds. Vermilion, used for paint and cosmetics (an ancient use) is the sulphide. Mercurochrome is a quarter mercury; calomel, a seed disinfectant as well as a medicine, is 85 per cent mercury; and corrosive sublimate is 74 per cent mercury. Compounds of the metal are used as catalysts in making acetic acid, caustic soda, and chlorine. Ships may be protected with a mercury antibarnacle paint. The dentist may use vermilion to color his plates to match the gums, and mercury amalgam (formerly much used in smelting gold and silver) in making metal fillings. Mercury goes into electric arcs and lamps for signs.

Even the felt-hat industry depends on mercury. The process of making fur into felt uses mercuric nitrate. "Mercury-made" oils are kept at the right temperature in refining by means of a mercury heat bath. For such purposes, of course, the mercury is not used up.

Floating-Lift Airplane

THE AEROPLANE

ANOTHER step in airplane safety and simplicity has been made possible through the invention of "floating lift" by Frank T. Courtney, an aeronautical engineer of Great Britain. As described in *The Aeroplane* of Oct. 19, 1939, floating lift applies old principles in a new way. At first sight it seems similar to methods which have been tried before, but its simplicity conceals entirely new features. The simplest definition of a floating-lift airplane is, for example, a monoplane in which the wings are rotatable separately about the main spar. In other words, they will have individually variable incidence.

As shown in Fig. 2, the wings are governed, as regards their angle of incidence, by separate surfaces mounted on booms, similar to individual tailplanes. These surfaces are controlled from the pilot's seat in such a way that the rods, cables, or other means pass through the point of attachment of the wing to the fuselage. Each wing and its tail surface, therefore, conforms with the well-known principles of longitudinal control and stability. The difference from ordinary practice is that the center of gravity does not change, in so far as it concerns the wing, because it is always on the hinge line. Each wing, with the stabilizing surface properly set, can be made automatically stable at certain angles of incidence, limited to prevent excessive diving and complete stalling.

The position of the fuselage is governed by a separate tailplane or stabilizer and is relatively unimportant except as regards resistance, and thereby efficiency. Directional control is obtained by the orthodox rudder. Lateral stability in this type of airplane is inherent and not controlled. As each wing maintains a constant-lift coefficient at all times, being an inherently stable airfoil free to take up its predetermined angle, pendular stability has some effect, but this is not relied upon. Dihedral in the ordinary sense is useless, because its tendency to increase the incidence of the low wing by sideslipping is counteracted by the floating-lift principle itself, which tends to keep the incidençe constant. Dihedral can be introduced by turning up the extremity of each wing, by having separate inclined vanes or a central vertical fin over the fuselage.

The righting force need only be small, because there is practically no damping in roll. Chief advantages of the floating-lift principle are the reduction of controls to two and the fact that the machine can be flown very slowly without danger of stalling or spinning.

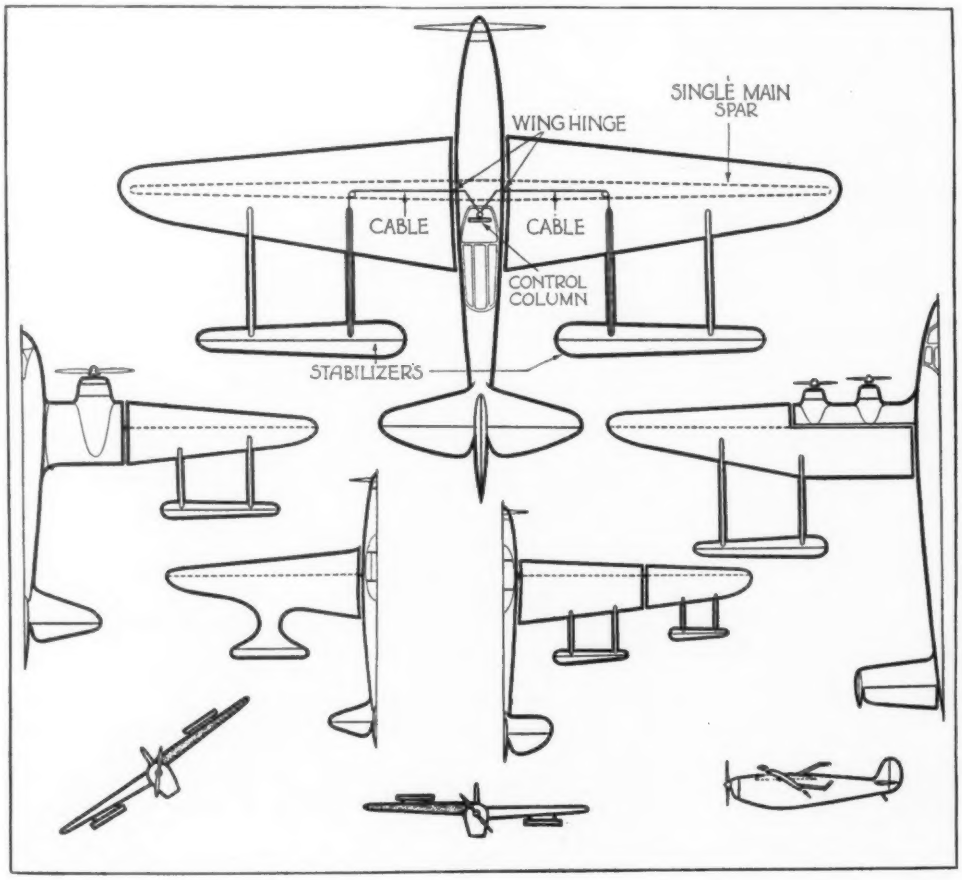


FIG. 2 APPLICATION OF FLOATING LIFT TO VARIOUS TYPES OF AIRPLANES

(Diagrams show the possible layouts of airplanes with floating-lift control. The bottom-left diagram is a head-on view of an airplane recovering from a turn, which demonstrates the lateral stability of the control and how the wings automatically maintain constant and equal lift. In the middle diagram, the wings conform to the relative air flow, and maintain equal angles of incidence and lift by tilting, respectively, downward in the up-bump and upward into the down-bump, as shown in the diagram at the bottom right. In the latter diagram, the dotted lines show the wing section in the normal flying position and the continuous lines illustrate the wing at the incidence of highest lift with slot and flap in action.)

Hydra-Matic Transmission

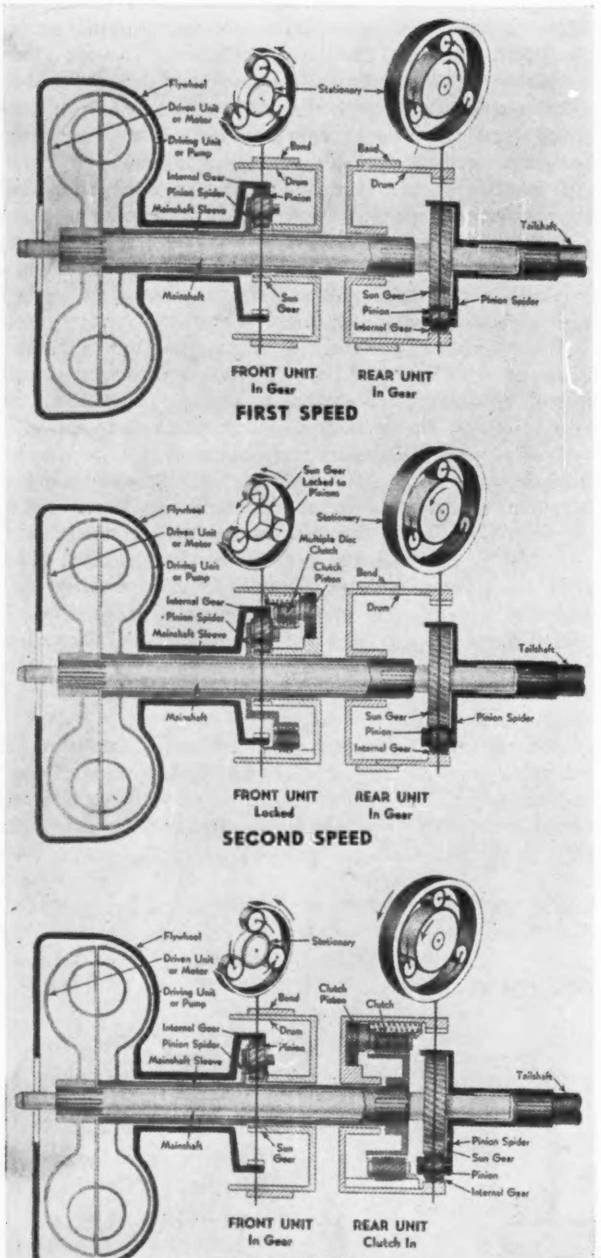
MOTOR (NEW YORK)

ELIMINATION of the conventional clutch and its pedal in the 1940 Oldsmobile is accomplished by the introduction of a fully automatic four-speed transmission combined with a highly efficient fluid coupling. As described in the October, 1939, issue of *Motor* (New York), the car is started from rest and driven entirely by means of the accelerator. In some of its features, it resembles the semiautomatic unit brought out in 1937 by General Motors. But the present mechanism has been completely redesigned to render it fully automatic. The shift control is operated hydraulically, whereas a number of cams, levers, and rods were used in the previous device.

The fluid or liquid coupling is similar in operation to the one which was described in this section in the August, 1938, issue of MECHANICAL ENGINEERING. The transmission consists of two planetary units which provide the four forward speeds, and a reverse planetary unit. The illustrations shown in Fig. 3, although drawn to scale, are strictly diagrammatic and omit such details as bearings, bolts, flanges, and splines. The flywheel, for example, is necessarily made in two pieces which are bolted together instead of being a single piece as shown. In this description, the three units will be called front, rear, and reverse. The front unit gives a gear reduction of 1.44 and the rear-unit reduction is 2.53.

In first speed the gears in both units are in action, the total reduction being 1.44 times 2.53 or 3.64. In second, the front unit is locked together and the gears in the rear unit are in use, giving a reduction of 2.53. In third, the front-unit gears are used, the reduction being 1.44, while the rear unit works on a one-to-one basis although not locked up. In fourth, the front unit is locked together and the rear unit also gives a one-to-one ratio although not locked. Power flow through the four forward speeds and reverse is shown in Fig. 3 by five separate diagrams in which only the parts actually in use are illustrated. Arrows on the perspective sketches of the gears indicate direction of rotation.

Bands and clutches are operated by oil pressure through valves jointly controlled by throttle position and governor. Both front and rear clutch pressure plates are acted on by six small pistons which hold the clutch in engagement when oil pressure is applied. The front planetary band is contracted by oil pressure acting on the dual piston. The main piston ap-



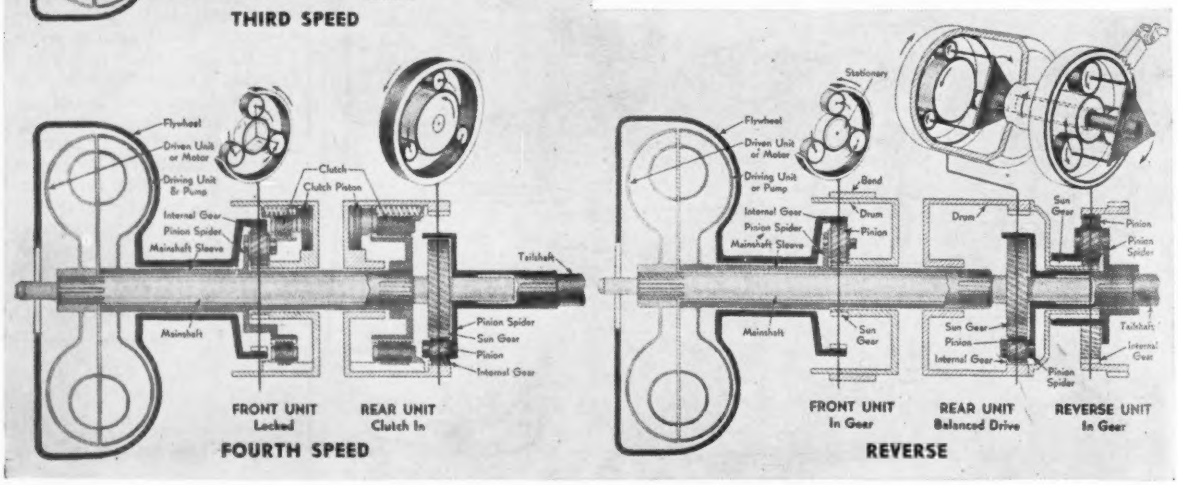


FIG. 3 OPERATION OF HYDRA-MATIC TRANSMISSION DIAGRAMMATICALLY ILLUSTRATED

plies a certain amount of force to the band and then as the throttle is opened additional pressure is applied to an auxiliary piston to increase holding power with torque. The front band is released by oil pressure and a light spring which insures freedom from drag. The rear band is held away from its drum by oil pressure on a piston. The band is applied by releasing oil pressure from this piston thus allowing springs to lock band to drum. As the throttle is opened increasing oil pressure

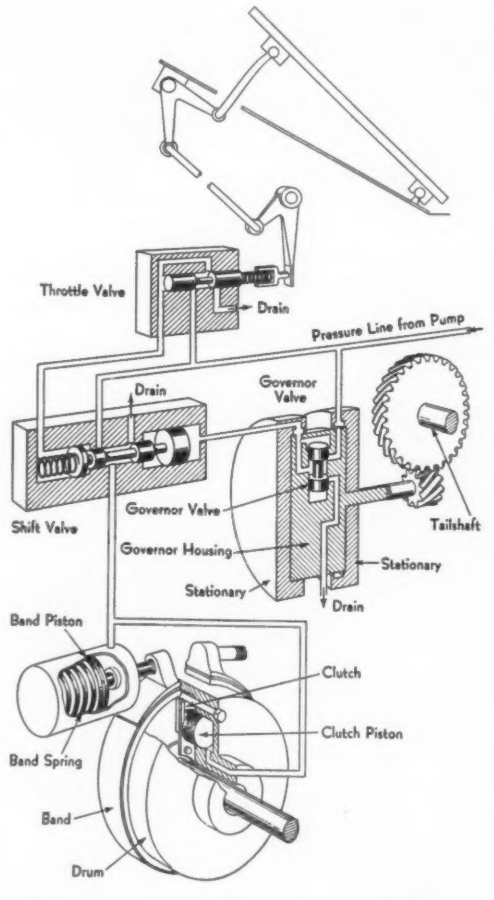


FIG. 4 OPERATING MECHANISM AND GOVERNOR OF THE HYDRA-MATIC TRANSMISSION

is applied to another piston to hold the band securely in place as torque increases.

The shifting mechanism is illustrated in simplified form in Fig. 4. The planetary unit is locked directly by applying oil pressure to the six clutch pistons and at the same time the band is released by oil pressure on the band piston. Oil pressure is obtained from the main line by moving the shift valve to the left, closing the discharge port and connecting the oil-pressure line to the pistons. To engage the planetary gears, the shift is moved right shutting off the oil-pressure line and opening the drain port, removing pressure from all pistons and allowing the coil spring back of the band piston to lock the band against the drum. Thus, an upshift is made by sliding the valve left and a downshift by moving it right. The shift valve is moved by pressure on its two ends. Oil pressure on the right is controlled by the governor and is proportional to centrifugal force. On its left, in addition to spring pressure, there is also oil pressure which increases with throttle opening by means of the throttle valve connected to the accelerator pedal.

The governor consists of a piston valve sliding radially in a housing geared to the tailshaft, or rather there are two governor valves of different weights. The heavier one controls the shift from first to second; both are used for second to third; and the light one for third to fourth. The governing mechanism is so designed that the pressure on the shift valve is proportional to the centrifugal force acting on the governor—up to the maximum pressure supplied by the pump. The pressure port opening grows larger in size as centrifugal force increases. Therefore, the oil pressure on the shift valve increases with centrifugal force. Consequently, the shift valve is positioned by throttle (and spring) pressure and governor pressure. When governor pressure exceeds throttle pressure an upward shift is indicated and when throttle pressure predominates, the planetary gears are called into use.

Multifuel Engines

THE AUTOMOBILE ENGINEER

SEVERAL internal-combustion engine manufacturers, both in the United States and in Europe, are now producing for commercial use engines which, with a few minor adjustments or none at all, can operate on gasoline, oil, gas, or alcohol. Descriptions of these various engines, which follow, have been abstracted from articles appearing in *The Automobile Engineer* for October, 1939.

The Waukesha Company recently brought out in the United States a version of its Hesselman type Diesel engine which can be easily converted to run either on gasoline or as a gas engine. Having a bore and stroke of $4^1/_2 \times 5^1/_2$ in. at the governed speed of 2100 rpm, the engine, shown in Fig. 5, develops 125 bhp with a compression ratio of 5.8:1. This corresponds to a bmep of 88 psi. As in other Hesselman engines the combustion chamber is formed in the piston crown. Crankshaft and cylinder block are cast in one, while cylinder liners of molychrome iron are inserted. Interchangeable twin cylinder heads integral with water-cooled exhaust ports are fitted. Both spark plugs and injector nozzles are in the head.

The Fiat-Boghetto engine made in Italy combines certain advantages of the Diesel engine, namely, low-priced fuels and low specific consumption at all loads, with those of the gasoline engine, namely, hand starting, smoother running, and lower internal pressures. The engine is of the injection type with a comparatively low compression ratio of 7.2:1. Its

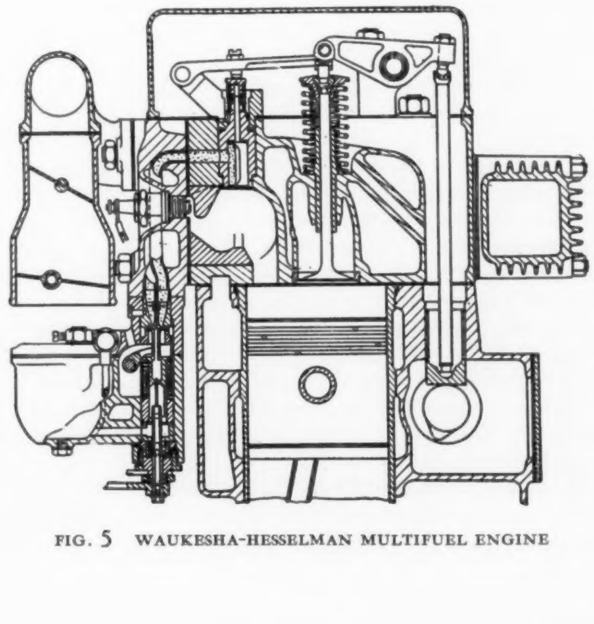


FIG. 5 WAUKESHA-HESSELMAN MULTIFUEL ENGINE

main working characteristic is that it takes a full admission of air at all loads, up to one sixth of the maximum load, therefore its consumption at low loads follows the same consumption law as that of the Diesel engine.

The basic principle of this engine is the stratification of the fuel mixture in a chamber which may be considered as separate from the power cylinder. As shown in Fig. 6, the combustion chamber is of elongated cylindrical form with a biconical mouth which has its outlet in the cylinder eccentrically to the center line without being actually tangential to the cylinder wall. Owing to the position of the combustion chamber, which is not subject to the influence of the passage of the suction air or of the exhaust gases, it remains at the end of the suction stroke, full of burnt gases at the same pressure as the air in the cylinder, that is, slightly below atmospheric pressure. During the following stroke the volume of burnt gases in the upper part of the chamber decreases continually. It is under pressure from the underlying column of air, which rises until it occupies a volume which may be taken as equal to oneseventh of the total volume of the chamber.

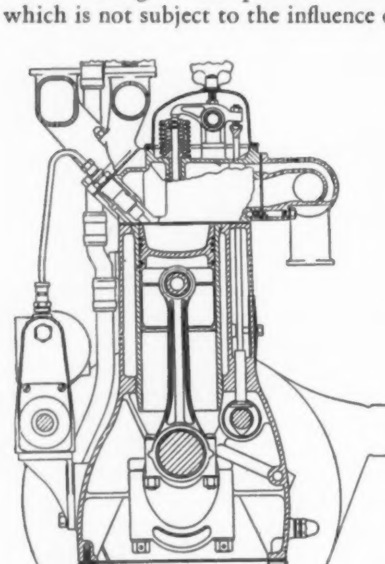


FIG. 6 THE FIAT-BOGHETTO MULTIFUEL ENGINE MADE IN ITALY

Before the piston reaches dead center, the fuel is injected into the cylinder in the direction of the mouth of the chamber. Here it meets the air coming from the cylinder and, by the effect of compression, mixes in the combustion chamber. The particles of pulverized liquid striking the ascending column of air give rise to a homogeneous explosive mixture without any artificially created whirling or turbulence. The spark plug, situated practically at the upper limit of the carbureted air zone, provides the ignition as in an ordinary gasoline engine. With a few minor adjustments, gasoline or alcohol may be utilized as the fuel for the engine.

The Brandt-Bagnulo engine, made in France, is an internal-combustion engine fitted with a special cylinder head and differs from the normal gasoline or Diesel engine while retaining certain characteristics of each. Like the gasoline engine it has positive electric ignition, but differs materially in the method of carburetion and the system of separately introducing the fuel and the main air supply. In comparison with the Diesel engine the air compressed in the cylinder is injected into a gasified fuel instead of liquid fuel being injected into the compressed air. For the Brandt-Bagnulo system is claimed the efficiency of the Diesel engine combined with the lightweight, flexibility, simplicity, and ease of maintenance of a gasoline engine. Over both types it has the outstanding advantage of functioning either on gas or on light and heavy liquid fuels.

The cylinder head of the engine is shown in Fig. 7, and it should be noted that in all other respects the engine is completely normal. Providing arrangements are made for a suitable compression ratio any standard gasoline or Diesel engine can be readily converted. In the head casting there is provided for each cylinder a special antechamber in which carburetion, vaporization, and the initial combustion of the fuel takes place. The antechamber is in open communication with the working cylinder by means of a tangential passage. Fuel and air from a jet-type mixing device are admitted to the antechamber by a supplementary valve actuated through a relay lever from the normal inlet-valve rocker. The mixing device has two constant-level float chambers to permit the use of two grades of fuel either separately or simultaneously. Communication from the mixing device to the supplementary valve in the antechamber is provided by tubes cast in the plate attached to the side of the cylinder head and closing the antechamber. Normal inlet and exhaust valves are mounted vertically in the cylinder head and actuated by overhead rockers.

It is interesting to note that the separate introduction of fuel and air, which is a necessary condition for the gasification of the fuel before carburetion, permits the air charge to be admitted to the working cylinder in a cool state which is favorable to good volumetric efficiency. Not less important is the fact that the efficiency of the engine does not vary with fuels of different calorific value. While maintaining the complete filling of the cylinders with pure air and feeding a quantity of fuel to the antechamber in inverse proportion to the calorific value, the number of heat units consumed remains substantially the same for all fuels.

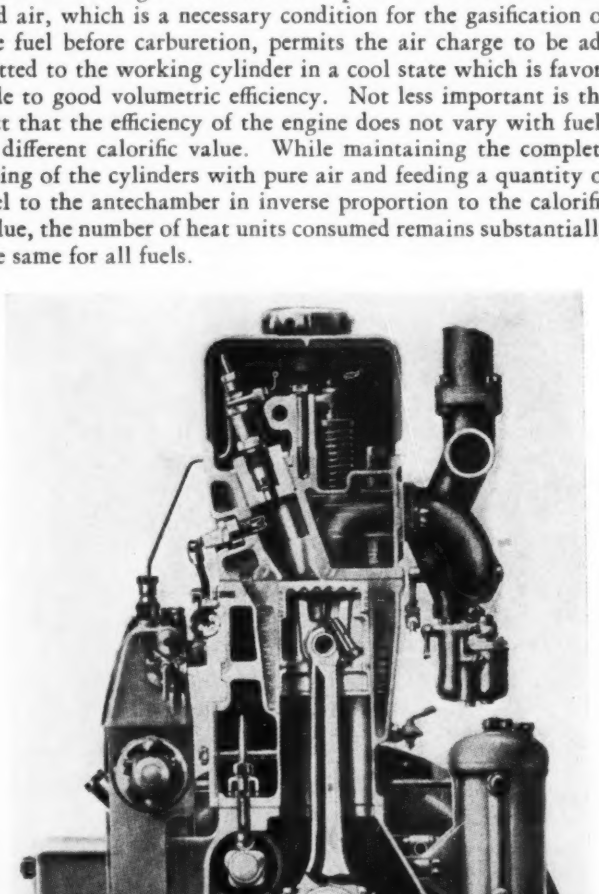


FIG. 7 THE BRANDT-BAGNULO MULTIFUEL ENGINE MADE IN FRANCE

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Immersion Quick Freezing

To the Editor:

This interesting paper[1] opens up many questions in a most interesting field and helps to answer some of them. Agriculture has been the stepchild of modern industrial organization, though there is some question as to whether the direct children (the urban industrial workers) have fared any better than have the stepchildren. The interests of both country and city dwellers are in fact inextricably intertwined.

We are concerned in our economy with two problems—one is that of stability, and the other is that of a high standard of living. We can attain stability (aside from the influences of the weather) by degenerating into a nonindustrialized subsistence type of agriculture, something like the mountain agriculture of the region in which the authors have been working.

This is not the solution the authors have in mind. They are looking toward one which gives stability on a higher standard of living. There are a number of reasons for believing that a weaving together of industry and agriculture in agricultural regions will lead toward a greater measure of stability at a higher standard. For one thing, regional solutions, even though the regions overlap, should have a higher degree of inherent stability than solutions in which the whole balance is concentrated in a central metropolitan financial area. Again, industrial developments based on food are essentially more stable than those concerned with other business activity. Lastly, though not finally, the stability of the individual family is improved by its contact with the soil, and this stabilizes the whole society made up of these individual families.

The technical process described is of interest in itself and appears to have hopeful business possibilities. Its successful development in the Tennessee region would warrant its widespread expansion.

We are fortunate in having this paper to remind us that the public-utility wrangle, into which political forces have directed the Tennessee Valley experiment, is by no means its only aspect. The original idea and the announced purpose were highly useful, and work under them is still going on.

Ralph E. Flanders.[2]

To the Editor:

The following comments are based upon (*a*) several years of experience in refrigeration engineering, in the storage of foodstuffs and in the design and operation of markets; and (*b*) on even a longer study of economics, especially of engineering economics.

The care shown in the research carried out is considered highly commendable and the authors are to be congratulated on the successful outcome.

The writer is sympathetic with their evident desire to justify the social soundness of their work, but is very skeptical of the cogency of their line of reasoning. The invention of practically every new device, process, or method tends to upset the social equilibrium (or approach to equilibrium) which existed previously. The least upsetting are the ones which simply relieve the worker of some of his physical effort without any economic or other change. If the invention makes possible a reduction in the time required to do the previous amount of work so that the worker can produce more of the same commodity or can use his saved time for other advantageous activities, then he can raise his standard of living, provided he is able to dispose of any extra products made during that saved time to other workers who are similarly fortunate as to saved time which they spend in making or doing something which is desired by the first worker. Unless the second group exists, then the saved time of the first group can be spent only on itself. Incidentally, longer hours of work are essentially equivalent to the saved time which may be made available by invention.

In a stable population with a scheme of stable production and equal consumption, inventions which increase the production of any one item (such as quick-frozen foodstuffs) will be useless unless some other device is simultaneously created which enables other groups to produce exchangeable goods. At the same time, if the new invention so lengthens a portion of a process as to take over some or all of the labor of another group, then the latter group must be provided with other means of earning a livelihood or with a dole (logically contributed by the group which benefits from the invention).

Based on the above premises, the writer believes that the authors' philosophical justification of their work is not sound. It is also felt that nature is an evolving entity, in connection with which, progress is that which coincides with the direction of the evolution at the time and place involved. Such advances in any art, as those made by the authors, are all in the course of the present evolutionary trend and are worth-while in themselves, even though they may throw some urban workers out of jobs in canning factories and there may be but little immediate demand for the new products.

Ernest P. Goodrich.[3]

To the Editor:

The writer believes that this paper has great merit.

The state experiment stations are vitally interested in bringing the farmer and investor or processor closer together; but, as stated by the authors, it is believed the place of the meeting should be in rural or semi-rural environment. In doing this, the industrialist will lose nothing, while the farmer will gain much.

By locating numerous small-unit industries "within hauling distance" of farmers, a triple benefit comes to him: (*a*) He has a market for his produce while it is fresh and at its peak in quality; (*b*) he and his family engage in transporting and processing the product; and (*c*) he is often a codirector of the plant and participates in the spread between producer and consumer.

The two last benefits may not amount to so much financially, but they tend to make a new man of him, in so far as being a useful citizen in a democratic com-

[1] "Immersion Quick Freezing; Its Application to Rural Processing Industry," by John P. Ferris and R. Brooks Taylor, Mechanical Engineering, June, 1939, pp. 437–442.

[2] President, Jones & Lamson Machine Company, Springfield, Vt. Past-President A.S.M.E.

[3] Consulting Engineer, New York, N. Y.

munity. The writer knows of definite cases where the social benefits from seasonal gatherings of near-by people at locally operated industries were of immense value above the amount of money received. On the other hand, money spent in rural industrial communities is circulated many times before it is invested.

Work in our laboratories shows that the speed of freezing or ice formation in fruits is the crux of the problem of freezing preservation in so far as mechanical engineering is concerned. On this depends the size of ice crystals, the firmness of the defrosted product, the amount of leakage, and, to a great extent, the vitamins which remain in the defrosted product.

Freezing by immersion seems to the writer to be the most practical and rapid method of freezing peaches to prevent browning (oxidation). The film of sugar syrup about each slice protects it from air with not more than 1 per cent added sugar. In this way the amount of sugar in the stored product is practically nil.

The question of packaging becomes very simple when the product is immersion frozen first. Of course, the usual precaution against desiccation is necessary; but no attention need be paid to adhering to definite dimensions or sizes of containers. It seems that this method is a step forward in standardizing frozen products.

We hope that the authors will continue to work for new rural industries in the cotton-belt areas.

H. P. STUCKEY.[4]

[4] Georgia Experiment Station, Experiment, Ga.

TO THE EDITOR:

This paper is unique in that it emphasizes the place of a processing method in bringing about a more complete industrial and agricultural balance. Naturally, a paper of this type is vulnerable to attack on several fronts, depending upon whether a social, economic, or technical viewpoint is taken. Moreover, it is extremely difficult to make a comprehensive appraisal of a problem of this type.

It is typical, however, of many agricultural problems involving some form of processing, in that distinct problems of engineering, plant breeding, crop culture, community organization, storage, transportation, and marketing are involved. These must be put together into a practical industrial system of mutual profit to those concerned with production and processing, as well as to the ultimate consumer.

The immersion method of quick freezing for fruits undoubtedly has merit for products which in their natural state are rather fragile and where the size of crystal must be controlled. The use of a solution containing invert sugar would seem to be practical for relatively high-temperature quick freezing of fruits. That the quality of product was acceptable is evidenced by the premium prices obtained.

Economic considerations in the establishment of a food enterprise are involved and difficult to analyze, yet these are important if a better economic balance between industry and agriculture is attained with the view of "increasing income to farmers, essential to soil conservation." The authors state, "Tennessee strawberries, for instance, have over a period of years left about $4^1/_4$ c per lb in the area when shipped out in raw-product form. If marketed in quick-frozen form, the same crop could leave an income of from 8 to 11 c per lb in the area, which is more than double."

This would be a remarkable increase in income, particularly if it could be reflected in a like improvement of income to the grower who is responsible for soil conservation. It would seem doubtful, however, from the limited data submitted, if a very large proportion of this increase would go to the grower. A 2000 lb per hr plant, operating continuously, requires 1000 girls in capping and inspection. If these girls work in 6-hr shifts even at the minimum rate of 25 c per hr, labor alone will absorb 3.1 c of the increase in community income. It is reasonable to assume that the farmer will obtain only a part of the remainder and in some cases the industry may provide no more than an enlarged farm-market outlet.

This type of industry, for strawberries, does provide a local labor market both for picking and capping. Picking may be handled partially at least by farm labor but capping will require the use of outside labor. These two labor demands coming together may create a peak-labor demand, affording opportunities for labor unrest, during the critical harvest-and-processing period.

Farming is a combination of subsistence living and production for profit. The latter is competitive and to that extent a local food industry is always unstable unless production and processing costs can be maintained at levels providing a satisfactory income to those engaged in these enterprises.

There are other crops which offer much more favorable opportunities to growers than strawberries, which unfortunately require so much hand labor during harvest, a considerable portion of which is of the widely heralded stoop type. Peas, for example, may be grown, harvested, and largely processed by machinery. With farm machines, the grower has a better opportunity to improve the family income and he is less likely to be interrupted by labor disturbances.

Any quick-freezing plant, as the authors point out, must be adaptable to a variety of products which will make it possible to lengthen the operating period, so that strawberries in themselves do not represent an acceptable crop index.

The general application of this method of crop processing will naturally result in some economic shifts in the food-processing industries. Unless consumption can be very materially enlarged, as a result of reduced production and processing costs, thus enabling consumers of the lower income brackets to enjoy these foods, quick freezing will to some extent take the place of canning processing and this in turn may tend to shift production areas. For example, the fresh-asparagus-production areas of the Carolinas may be brought into more direct competition with the favorable production districts in the Delta regions of California, or the favorable production environments for berries in the Pacific Northwest may offer severe competition to the berry districts of the Tennessee Valley.

Generally speaking, however, quick freezing of perishable products, such as fruits and vegetables, appears to the writer to offer greater advantages for growers of products located closest to our great consuming centers than for the more remote producing areas, unless unusually favorable climatic and soil conditions more than offset long-haul refrigerated transportation.

The authors are to be congratulated for the development of the immersion system of quick freezing which is so promising for processing certain of our perishable farm products. This contribution affords another example of engineering service in behalf of the agricultural industry.

H. B. WALKER.[5]

TO THE EDITOR:

The authors, in their presentation of a particular processing industry for farm products, have given us an interesting outline of the problems faced in an area which has for generations existed under an agricultural economy. They have suggested, through example, methods by which engineering may assist in solving the social and economic problems that a

[5] Agricultural Engineer, University of California, Agricultural Experiment Station, Davis, Calif.

changing economy in rural areas has presented.

The rural areas of the Southeast have become the frontier of a new industrial development. While the introduction of new industry, based on the processing of the area's raw materials, has aided materially in providing industrial employment to a part of the excess rural population, the character of this development is such that the economic independence of the states concerned is threatened.

A recent study of the rapid growth of new industry in one southern state may be considered to add substance to the authors' economic analysis of the problem facing the area. The study showed that, during the period following the World War, the "value added by manufacturing" has increased in this state by approximately 75 per cent. During this period the number of industrial wage earners has increased by approximately 60 per cent. The increased labor supply came largely from the rural areas and undoubtedly aided in absorbing much of the agricultural labor displaced by the factors indicated by the authors.

The trends indicated have been of great aid to many people of the state. On the other hand, this period of phenomenal industrial growth has seen the general financial status of the state drop far below that of the preceding period. In searching for an answer, other than the general depression, the character of the growth of industry in the state was carefully analyzed. The analysis indicated a decrease in the number of small industrial plants, almost entirely home owned, and a sharp increase in those large-scale industries owned almost wholly outside the area.

In 1919, those industries owned outside the state accounted for only 19.3 per cent of the total "value added by manufacturing," while in 1937, this had increased by over 300 per cent.

The term "value added by manufacture" embraces the fixed charges on industrial investment, taxes, wages, and profit. Where industry is owned outside the area, taxes and wages can only be considered as additions to the state's wealth. Thus interest and profits have been leaving the area in an ever-increasing proportion from year to year.

A concentration of engineering research and development efforts, perhaps state supported, on small local industries in rural areas, such as suggested and exemplified by the authors, may well be expected to aid in bringing about a balance between local and absentee ownership. The industrial development taking place from without has proved itself a great economic aid. But the stable wealth of an area cannot be measured by taxes and wages alone. These are quickly dissipated in services and in the necessities of living. Interest on capital investments and profits, reinvested in the area, are the only true measures of stable wealth.

F. L. WILKINSON, JR.[6]

TO THE EDITOR:

It is significant that the interest of those who commented on our paper seems to lie in the economic implications of the technical development which we described.

This phase of the project, as opposed to the completed development of process and equipment, is still in the experimental stage. Some of the problems to be solved, if operation as a local rural industry is to be a success, are listed in our paper.

H. B. Walker points out that the farmer is not likely to get much more for his product than if he sold it on the fresh market. Experience in other parts of the country, where agricultural processing industries have operated for some years, indicates that a freezing plant offers the grower possibility of increased income because it provides a more certain market at more stable prices. Furthermore, freezing can absorb a greater percentage, as much as 15 per cent more, of the crop, including fruit fully ripe that would spoil if shipped to fresh markets. These advantages have been shown to encourage growers to adopt improved agricultural practices which increase yields and income.

In the area in which the experimental freezing plant described in our paper is located, growers in some years have left much of their strawberry crops unharvested because crops of other areas ripened at the same time, and the markets could not absorb all of them in a few weeks' period. Under such conditions farmers could not be expected to adopt the soil-conservation practices needed to produce quality products or maintain their lands on a permanent basis.

Further benefits to the individual farmer may well come from the increased community income resulting from the establishment of freezing plants. The calculated doubling of income of an area from its strawberry crop was based on value of pay rolls of girls and men needed for capping and plant operations and on the purchase locally of some supplies and materials. Part of the cash paid out for these items will go to the farmer or to members of his family. Another consideration is that the farmer may profit from operations of the plant itself if he has a financial interest in it.

The danger of peak-labor demands attracting transient labor is not yet a problem in the Southeast, as it seems to be in the commercialized farming areas of the far west. There is a surplus of rural labor in most Tennessee Valley counties not now needed by agriculture or industry. Another safeguard is that a variety of crops may be processed throughout eight months of the year; the employment period can be quite long, so that transient labor is not needed. The list of commodities which have been frozen at the experimental plant has included in sequence peas, strawberries, youngberries, peaches, lima beans, corn, apples, poultry, and meats.

JOHN P. FERRIS.[7]
R. BROOKS TAYLOR.[7]

Quarter-Turn Belt Drive

TO THE EDITOR:

The accompanying photograph (Fig. 1) shows an unusual drive that may interest your readers. The quarter-turn

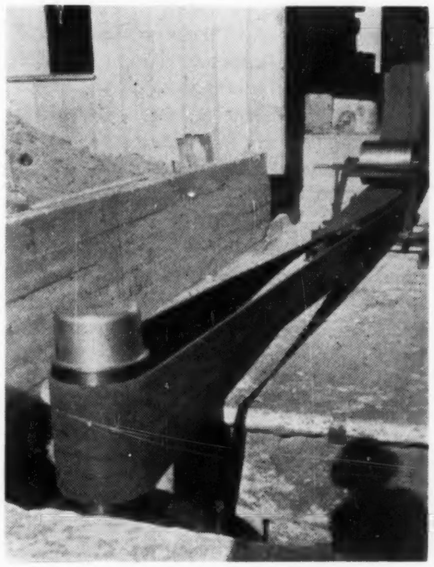


FIG. 1

belt shown transmits 150 hp from an engine pulley 78 in. diameter to a pump pulley 11.85 in. diameter at 1760 rpm.

The single-pulley track-type idler provides belt-tension control and is designed so that the belt does not run off when the drive runs backward.

H. M. PERRY.[8]

[6] Dean, Speed Scientific School, University of Louisville, Louisville, Ky.

[7] Commerce Department, Tennessee Valley Authority. Members, A.S.M.E.

[8] Los Angeles, Calif. Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Applied Economics for Engineers

APPLIED ECONOMICS FOR ENGINEERS. By Bernard Lester. John Wiley & Sons, Inc., New York, 1939. Cloth 6 × 9 in., 464 pp., 7 figs., $4.

REVIEWED BY W. D. ENNIS[1]

THE author is responsibly occupied in industrial marketing for the Westinghouse Electric & Manufacturing Company. His previous book, "Marketing Industrial Equipment," is favorably known. These facts account for the gratifying emphasis, in the present volume, on the customer point of view as encountered in selling, advertising, and the analysis of consumption. With respect to such emphasis, this book is new. Consumers seem no longer to break trail toward better mousetraps.

The last year or so has given us several new books in industrial economics—the new Grant, Rautenstrauch, the new Bowers and Rowntree, and now this. The differences are more interesting than the likenesses. After forty years, there is still no standardization of subject matter. There is probably, even, no agreement on definition. Books written by college teachers in this field often try to cover matters which teachers in other fields think should be covered. A weakness develops. The mechanical engineer desiring a course in electrical engineering for his students says "leave out the higher math and show them how to select the proper type of motor for an assigned condition." This sounds very simple, if you know nothing about electrical engineering. So any engineer says to the engineer-economist, "show them how to bring in $ as well as $\int$." And too often this leaves us where we were, 'assuming 5 per cent interest.' Why 5 per cent? When, where, and why that figure or some other? *That* would seem to be part of, and perhaps fundamental to, the problem. Leaving it out is parallel with Mr. Lester's treatment of the business cycle with no discussion of money rates.

The author is a lecturer at the University of Pittsburgh. Throughout the book the most impressive thing is the apparent earnest desire to be helpful to the young graduate. He is even exhorted to do well, to excel as engineer and as citizen. In his behalf, the book is distinguished by its breadth of view and inclusiveness. Reading references are abundant and documentation is conscientious. As a single-course text, the book has the advantage of including a treatment of what is usually called ***industrial engineering:*** location, layout, and equipment of plant. The author is modest in the connotation he implies for economics: It is a showing of how business is done, here, now. Appended to the body of the text are a number of problems, of practical dimensions and complexity, most of which are quantitative, i.e., arithmetical. This is to be noted, because at some points in the book there is an omission, not to say an avoidance, of quantitative treatment. One reads more than one quarter of the book before encountering any substantial amount of it.

It follows perhaps, that it is vain to look here for decisive figures on such diverse matters as technological unemployment, the distance limitation for electric transmission, the sacrifice of energy efficiency often involved in direct motor drives, the break-even point in problems of engineering choice, the "dominant" importance of the corporation, index number methodology, and economic lot sizes. And in a quantitative subject like the demand-supply-price relationship the charts and discussion are puzzling. In offset, the discussion of preferred numbers is good, although at one point vague; and the author courageously attacks the subject of quality control by inspection of samples, a subject which even here has been insufficiently predigested for the lay reader—and which badly needs to be.

The subject matter of the book may be summarized in four phase groups by chapter units:

1 The place of the engineer in social and economic life; human and public relations in industry; 3 units, scattered.

2 Planning and organization, standards, development, and production; 6 units.

3 Accounting, cost accounting, statistics, purchasing, and (problems involving) economic studies; 4 units.

4 The consumer (a separate chapter), followed by a consecutive and orderly treatment of market, distribution, selling, and price policies; 5 units.

One must note, however, a habit of scattering the discussion of a definite topic in different parts of the book, a habit which even the index suggests. It may be a result of this that points of apparent importance seem often to have been omitted. Patents are referred to briefly in two places, with nothing on important new proposals as to procedure and no reference to certain touchy matters of business ethics. The pages on labor do not mention the three new Federal statutes and their administration, and ignore topics as timely as job evaluation and merit rating. They omit all but the older bonus plans of wage payment. The discussion of quantity differentials in price is not tied in with the separate presentation (in a preliminary chapter) of the Robinson-Patman Act. With two separate references to electric rates, there is no recognition of the economic utility, and limitations of application, of class pricing.

It would be captious to quarrel with questions of respective individual emphasis. Mr. Lester has found a great deal to say in his 464-page self-imposed limitation. The book will no doubt go into further editions. If and when this happens, some of us, at least, would like to see more ample recognition given to accounting and cost accounting, perhaps to theories of taxation (e.g., benefit principle vs. ability-to-pay principle), workmen's compensation laws, capital turnover (especially in connection with break-even charts), the dominant place of obsolescence in depreciation, increment costs, and other topics—forecasting as many topics ultimately, the author may protest, as there are readers.

Two things it would surely be well to do: First, in the discussion of valuations, bring in some court decisions on basic points; second, avoid the use of "imaginary" organization charts in favor of examples actually taken from the field.

The book has its own distinct place.

[1] Humphreys Professor of Economics of Engineering, Stevens Institute of Technology, Hoboken, N. J. Fellow A.S.M.E.

Books Received in Library

APPLIED ECONOMICS FOR ENGINEERS. By B. Lester. John Wiley & Sons, Inc., New York, 1939. Cloth, 6 × 9 in., 464 pp., diagrams, charts, tables, $4. This book provides an introduction to the practical aspects of economics, based upon the conditions and problems encountered in engineering practice. Stressing the importance of habitual reference to current technical literature the author presents practical information on industrial relations and organization, standards, statistical and accounting methods, development and production problems, costs, markets, distribution, and sales.

ATLAS METALLOGRAPHICUS. Band 2, Lieferung 7, Tafel 49–56, Abbildungen 353–418. Band 2, Lieferung 8, Tafel 57–64, Abbildungen 419–467. By Hanemann and Schrader. Gebrüder Borntraeger, Berlin, Germany, 1939. Paper, 8 × 11 in., illus., diagrams, charts, tables, Lieferung 7, 9 rm, subscription price, 7.20 rm.; Lieferung 8, 12 rm, subscription price, 9.60 rm. These two installments of the atlas complete the second volume, which is devoted to the structure of gray cast iron and chilled cast iron. They contain 115 photomicrographs of these materials illustrating the effect of composition, heat-treatment, and other factors, together with an explanatory text. The Atlas is a valuable reference work for the metallographist.

COMPANY PLANS FOR EMPLOYEE PROMOTIONS. By H. Baker. Industrial Relations Section of Princeton University, Princeton, N. J., 1939. Paper, 7 × 10 in., 48 pp., charts, $0.75. This pamphlet presents a brief analysis of the promotion programs of representative industrial companies. General procedures in promotional programs, training for promotion, publicity on programs and opportunities, and the effect of promotional plans are discussed.

DAVISON'S TEXTILE BLUE BOOK, United States, Canada, and Mexico. Seventy-fourth year, July, 1939, to July, 1940, handy edition. Davison Publishing Co., Ridgewood, N. J., 1939. Cloth, 5 × 8 in., 1166 pp., maps, $5. An annual publication containing lists of manufacturers of cotton, rayon, silk, and knit goods, and of dyers and finishers, geographically arranged. Commission merchants, dealers, and importers are listed, also domestic and foreign raw-cotton firms, cotton compresses, and warehouses. Two special lists cover pertinent associations and railroads serving the various mills.

DEUTSCHE KRAFTFAHRTFORSCHUNG im Auftrag des Reichs-Verkehrsministeriums. Heft 21: Korrosion durch Kraftstoffe, by G. Beck and R. Künzelmann. 35 pp., 3.60 rm. Heft 22: Reifenverschleiss bei Zwei- und Dreiachs-Lastwagenanhängern, by O. Dietz and L. Huber. 14 pp., 1.50 rm. Heft 23: Spülvorgang bei Zweitaktmaschinen, by O. Lutz and W. Noeggerath. 32 pp., 3.20 rm. Heft 24: Gemischbildung im Saurer-Dieselmotor, by K. Zinner. 8 pp., 0.95 rm. Heft 25: Reibungskräfte, Laufunruhe und Geräuschbildung an Zahnrädern, by G. Dietrich. 38 pp., 3.95 rm. V.D.I. Verlag, Berlin, Germany, 1939. Paper, 8 × 12 in., illus., diagrams, charts, tables. These bulletins of the German Automobile Research Board discuss the following subjects: No. 21, studies of corrosion resistance of various lacquers and metals to gasoline, Diesel oil, and other fuels; No. 22, the effect of various wheel and axle arrangements upon the wear of trailer tires; No. 23, the results of scavenging investigations of two-cycle engines; No. 24, the results of tests of the fuel mixture in the Saurer Diesel engine; No. 25, the factors that affect the behavior of gear wheels, especially quality of finish, shape, and pitch.

GERMAN-ENGLISH SCIENCE DICTIONARY for Students in the Agricultural, Biological and Physical Sciences. By L. De Vries. McGraw-Hill Book Co., Inc., New York, N. Y., and London, 1939. Leather, 5 × 7 in., 473 pp., $3. While this new dictionary has been compiled with special attention to the needs of students of agriculture and biology, it will be useful to a much wider circle. In a volume of convenient pocket size, it contains 48,000 terms relating to the biological and physical sciences, with accurate English equivalents. The volume is a valuable addition to the tools of the translator.

GMELINS HANDBUCH DER ANORGANISCHEN CHEMIE. System-Nummer 59: Eisen, Teil C, Lieferung 2, Prüfung der Kerbschlagzähigkeit. Edited by Deutsche Chemische Gesellschaft. Eighth edition. Verlag Chemie, Berlin, Germany, 1939. Paper, 7 × 10 in., 288 pp., illus., diagrams, charts, tables, 33 rm. The present chapter of the "Handbuch" is a valuable monograph upon the impact resistance of iron and steel, which summarizes the literature up to October, 1938. The topics discussed include: physical principles of impact tests; influence of test conditions upon results; usefulness of law of similarity; standard and special test pieces; changes of form in tests; testing castings and special materials; testing at high or low temperatures; interpretation of properties by impact testing; relations between impact resistance and other properties, etc. Numerous bibliographies are included. The work will be of great usefulness to all engaged in testing materials.

GMELINS HANDBUCH DER ANORGANISCHEN CHEMIE. System-Nummer 59: Eisen, Teil F II, Lieferung 2, Nachweis und Bestimmung von Fremdelementen in Eisen und Stahl. Edited by Deutsche Chemische Gesellschaft. Eighth edition. Verlag Chemie, Berlin, Germany, 1939. Paper, 7 × 10 in., 388 pp., diagrams, tables, 27 rm. This section completes the description of methods of iron and steel analysis in the new edition of this great reference work. An exhaustive review is provided of the methods for determining the elements that alloy with iron. In addition such special methods are discussed as the chromatographic, polarographic, and spectrum, the spark test, and other physical methods. Finally, the methods prescribed by standardizing organizations in various countries are given. As customary, the references to the literature are profuse.

Selections Illustrating the History of GREEK MATHEMATICS, with an English translation by I. Thomas. Vol. I: From Thales to Euclid. Cambridge, Mass., Harvard University Press; William Heinemann, London, England, 1939. Cloth and leather, 4 × 7 in., 505 pp., diagrams, tables, cloth, $2.50; leather, $3.50. The selections here presented cover the development of Greek mathematics from the time of its founder, Thales, to that of Euclid. They are given in the Greek with an English translation on the opposite page. The book aims to provide a reasonably complete picture of the rise of Greek mathematics which will be found useful by classical scholars and by mathematicians desirous of learning something about the origins of their science.

HEAT POWER. By E. B. Norris and E. Therkelsen. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Cloth, 6 × 9 in., 432 pp., illus., diagrams, charts, tables, $4. The major topics of the internal-combustion engine, steam engines, steam turbines, and boiler furnaces are presented in a simple manner, including theory, analysis of heat cycles and performance, accessories, and auxiliaries. This revised edition includes a chapter on refrigeration. Many numerical examples and problems help the student in his practical application of the information. The work varies the usual arrangement by commencing with the internal-combustion engine.

ILLUSTRATED TECHNICAL DICTIONARY: French, German, English, Spanish, Italian, Dutch. Chapter 2, Rivers, Streams, Canals. Edited by L. R. Wentholt. Permanent International Association of Navigation Congresses, General Secretariat, 38 Rue de Louvain, Brussels, Belgium, 1939. Paper, 8 × 11 in., 121 pp., diagrams. This addition to the illustrated dictionary in preparation by the Association contains the terms pertaining to rivers, streams, and canals. Six languages are included, English, French, German, Dutch, Spanish, and Italian. Illustrations are used as definitions.

INSTRUCTION MANUAL FOR SHEET-METAL WORKERS. By R. W. Selvidge and E. W. Christy. Manual Arts Press, Peoria, Ill., 1939. Cloth, 6 × 9 in., 167 pp., illus., diagrams, tables, $1.75. The fundamental operations in sheet-metal work are successively described, with definite directions for performing each operation. Questions are included to bring out the reasons underlying certain methods. A brief treatment of numerous topics of related trade information, standard data tables, and literature references are of additional help to the student or apprentice.

KORROSION VII. Bericht über die Korrosionstagung 1938 am 15. November, 1938 in Berlin; prepared by Arbeitsgemeinschaft auf dem Gebiete der Korrosion. Verein deutscher Ingenieure, Berlin, Germany, 1939. Cloth, 81 pp., illus., diagrams, charts, tables, 6 rm. This symposium on corrosion and its prevention contains eighteen papers. Special emphasis is laid on the effect of corrosion upon the operation of equipment, rather than as a destroyer of material, and on the need for attention to its effect when designing and constructing apparatus. The effect of corrosion on gas meters and regulators, water meters, electrical instruments, etc., is discussed.

LUBRICANTS AND LUBRICATION. By J. I. Clower. McGraw-Hill Book Co., Inc., New York and London, 1939. Cloth, 6 × 9 in., 464 pp., illus., diagrams, charts, tables, $5. In this comprehensive textbook the author devotes the first ten chapters to the fundamentals of lubricants and lubrication in such a way as to enable the student to analyze the requirements of most equipment. The following six chapters apply the basic principles to various machines and make specific recommendations for the analysis of equipment.

MANNING FORMULA TABLES for Solving Hydraulic Problems. Vol. 2, Flow in Open Channels. By H. W. King. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1939. Leather, 6 × 9 in., 379 pp., tables, $5. These tables give simple, direct solutions of the problems involving open-channel flow that are commonly encountered in engineering practice. The main table gives a solution of the Manning formula for the range of discharges from less than one to more than one hundred thousand cubic feet per second. Supplementary tables contain discharge factors adapting the formula to different types of problems and forms of sections.

PHYSICS. By E. Hausmann and E. P. Slack. Second edition. D. Van Nostrand Co., New York, N. Y., 1939. Cloth, 6 × 9 in., 756 pp., illus., diagrams, charts, tables, $4. The aim of this work is to present the essentials of physics to college students who major in science or engineering. It attempts to give a gradual, logical approach to the subject, and to develop and illustrate clearly the fundamental concepts. The new edition has been revised thoroughly, rearranged in the light of teaching experience, and provided with many additional problems.

SCIENCE AND MECHANIZATION IN LAND WARFARE. By D. Portway. Chemical Publishing Co., New York, N. Y., 1939. Fabricoid, 6 × 9 in., 158 pp., diagrams, charts, $2.50. Intended for students in the Cambridge University Officers' Training Corps, this book supplies, in nontechnical language, the principles and some of the details underlying the scientific side of modern warfare. The several chapters are devoted to a description of fundamental scientific principles, the importance of railways in war, the various aspects of mechanization, weather problems, chemical warfare, the work of the army engineer and the signal corps, the artillery survey, and some problems of personnel.

SENIORITY PRINCIPLE IN UNION-MANAGEMENT RELATIONS. By F. H. Harbison. Industrial Relations Section of Princeton University, Princeton, N. J., 1939. Paper, 7 × 10 in., 39 pp., $0.75. This study, based largely upon personal interviews with employers and labor leaders, is a digest of experience and opinion on selected aspects of the seniority problem as it applies to the relations of union and management in the mass-production industries. It summarizes the reasons for the demand for seniority rights in trade-union agreements, the degree to which seniority is modified by other factors, and the manner in which these modified rights are applied.

SOCIAL FUNCTION OF SCIENCE. By J. D. Bernal. The Macmillan Co., New York, N. Y., 1939. Cloth, 6 × 9 in., 482 pp., charts, tables, $3.50. Starting with a brief sketch of the historical development of science, the author proceeds to consider its present organization. He points out numerous reasons for the present confused and inefficient status of scientific research and the forces of prejudice which act in opposition to it. He then discusses certain ways in which a reorganization could be effected with the object of increasing the benefits which society can gain from scientific activity.

STEAM AND HOT WATER FITTING. By W. T. Walters. American Technical Society, Chicago, Ill., 1939. Cloth, 6 × 9 in., 184 pp., illus., diagrams, charts, tables, $2. A concise manual for those engaged in designing and installing these heating systems.

STEAM CONQUERS THE ATLANTIC. By D. B. Tyler. D. Appleton-Century Co., New York, N. Y., and London, England, 1939. Cloth, 6 × 9 in., 425 pp., illus., diagrams, maps, tables, $5. The history of the first sixty years of steam navigation on the North Atlantic, up to 1880, is related with full attention to all contributing activities. The author, while he lists and describes the more important and significant vessels of the period, is more concerned with the various forces which affected ocean commerce and the personalities who influenced its development, as inventors, designers, shipbuilders, financiers, politicians, ship captains, and even passengers. There is a large bibliography.

THE TECHNICAL COLLEGE. By W. A. Richardson. Oxford University Press, New York, N. Y., and London, England, 1939. Cloth, 6 × 9 in., 495 pp., illus., charts, tables, $5. The principal of a large English technical college surveys the field with a view toward increasing the efficiency of this type of education. He describes the organization and administration of the technical college, the physical equipment, and the types of students to be considered. Relations with industry are discussed, among other problems, and future developments are considered.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS THE policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-101. Add the following sentence to the first section:

Superheater headers not exceeding 16 in. nominal pipe size or $1^5/_8$ in. wall thickness which are not in contact with furnace gases may be fusion welded in accordance with Par. P-112.

PAR. P-112. Revise first sentence of (*a*) to read:

Circumferential joints of pipe or tubes BUT NOT WATER WALL HEADERS may be fusion-welded within the following limiting conditions and as provided in this paragraph:

Revise (1) to read

(1) Pipe or tubes AND SUPERHEATER HEADERS not exceeding 16 in. nominal pipe size or $1^5/_8$ in. wall thickness, that are to contain steam, and pipes or tubes [those] not exceeding 10 in. nominal pipe size or $1^1/_8$ in. wall thickness, that are to contain water, when in each case the welds are not to be in contact with furnace gases:

PAR. P-212. Add the following as (*c*):

(*c*) Openings located in the curved portion of the wrapper sheet of a locomotive-type boiler shall be designed in accordance with the rules in Par. P-268.

PAR. A-19*a*. Revise first sentence to read:

Fire-actuated fusible plugs, if used, shall be filled with tin of the following composition, having a melting point between 440 to 450 F:

PAR. A-19*d*. Replace the first sentence by the following:

Fusible plugs filled with tin as specified in (*a*) shall not be used with boiler water temperature in excess of 430 F.

TABLE P-11. Add the following footnote:

The reference to welded stays in Par. P-209 and to "welded stays or braces" in the above Table refers to the method of fabrication by forge welding of the part itself and not to the attachment of the stays or braces to the sheets.

TABLE L-4. Add the following footnote:

The reference to "welded stays or braces" in the above table refers to the method of fabrication by forge welding of the part itself and not to the attachment of the stays or braces to the sheets.

TABLE U-1. To be deleted.

PAR. U-10. Omit the words "as shown in Table U-1."

TABLE U-6. Add the following footnote:

The reference to welded stays in Par. U-50*b* and to "welded stays or braces" in the above Table refers to the method of fabrication by forge welding of the part itself and not to the attachment of the stays or braces to the sheets.

PAR. U-66. Add the following:

When a casing or other form of cover applied to an unfired pressure vessel is so arranged that it is not desirable to provide an opening through which the required stamping of the unfired pressure vessel parts may be viewed, the required stamping shall be duplicated on a nonferrous plate not less than 4 in. by 3 in. in size to be brazed or otherwise irremovably attached to the front portion of the casing, or it may be stamped in the metal of the casing itself.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Friendliness Is Keynote of Social Activities for A.S.M.E. 60th Annual Meeting in Philadelphia, Dec. 4–8

High Spots of Luncheons, Dinners, and Inspection Trips

FRIENDLINESS will be the main object of the many social functions being planned as a part of the extensive program for the Sixtieth Annual Meeting of the A.S.M.E. to be held at the Bellevue-Stratford in Philadelphia, the "city of brotherly love," Dec. 4–8, 1939. Believing in the old Quaker adage that friendships are more easily formed and bonded over tables of festive food, the Committee on Arrangements has scheduled more than the usual quota of luncheons and dinners.

And since this is the first time in 53 years that a National Meeting of the Society is being held in their city, the Philadelphians are making every effort in planning the inspection trips to give a complete picture of the many industrial plants to visiting members of the A.S.M.E. So far, 11 regular inspection trips to 19 plants and projects are scheduled. The Pennsylvania women are also doing their part in promoting the topic of friendliness by providing a special women's program which includes sight seeing, popular science, a beauty and fashion session, a trip through a soup plant, shopping, a doe dinner, and many other activities.

Monday Luncheon, Tea, and Dinners

As usual, the first get-together luncheon of the Meeting will take place on Monday, Dec. 4, when Council members and delegates of Local Sections and Professional Divisions adjourn their morning session. Early comers for the technical sessions in the evening and those who will have attended the Annual Business Meeting are invited to enjoy the tea which will be served in the Cocktail Lounge at 4:30 p.m. If the boys are still hungry, they can attend the Research Committee and Management Division dinners at 6:00 p.m.

Tuesday's Stag Party

On Tuesday, Dec. 5, hundreds of members and their guests will have an opportunity to get together for a real old-fashioned stag party (men only, the women will have their own doe party). Tickets for the men's affair are only $2 each and will include valuable prizes, snappy acts, pictures, buffet supper, refreshments, and a sing fest.

Wednesday, Dec. 6, has been designated as Student Day. The big event for hundreds of student members will be the Annual Student Luncheon, where prominent members will sit down with the students and talk things over. For the older members, the main feature is to be the Annual Dinner in the evening at which President A. G. Christie will deliver his presidential address on "Postgraduate Training of Young Mechanical Engineers." Because of the many social functions planned for the Meeting this year the 1939 Honors and Awards of the A.S.M.E. will be bestowed upon their recipients during the after-dinner program.

Later, members and their guests will be given an opportunity to meet the major officers of the Society. This will be followed with dancing until the wee hours of the morning.

Governor at Thursday Luncheon

A.S.M.E. members and guests will gather with other important engineering and business groups interested in the sound development of industry for luncheon on Thursday, Dec. 7.

BROAD STREET, PHILADELPHIA, LOOKING TOWARD CITY HALL

(A.S.M.E. Annual Meeting in Philadelphia, December 4–8, 1939.)

President Christie is to preside and Governor Arthur H. James, of Pennsylvania, will be the guest of honor. Richard P. Brown, member A.S.M.E. and secretary of the Department of Commerce, Commonwealth of Pennsylvania, will talk on the subject, "Industrial Pennsylvania Stages a Comeback." Tickets will be available at $1.50 each at Meeting headquarters.

Women's Program

Monday, Dec. 4

2:30 p.m. Annual Meeting of A.S.M.E. Woman's Auxiliary

4:30 p.m. Acquaintanceship tea

Tuesday, Dec. 5

10:00 a.m. Three-hour sight-seeing trip around historic Philadelphia

1:00 p.m. Luncheon at Old Bookbinders, most unique sea-food restaurant in the country

2:00 p.m. Visit to Franklin Institute

7:00 p.m. Doe dinner exclusively for women in North Garden, the Bellevue-Stratford roof. Talk on "This Beauty and Fashion Business," by Mrs. Walter Wood, formerly London director of Lucien LeLong, and presently Chicago director of Beauty Counsellors, Inc.

Wednesday, Dec. 6

9:30 a.m. Visit to Campbell Soup Co. plant where light refreshments will be served

1:00 p.m. Luncheon at Wanamaker's and personally conducted tours through the store

6:00 p.m. Annual Dinner

Inspection Trips

Tuesday afternoon, Dec. 5

Trip 1

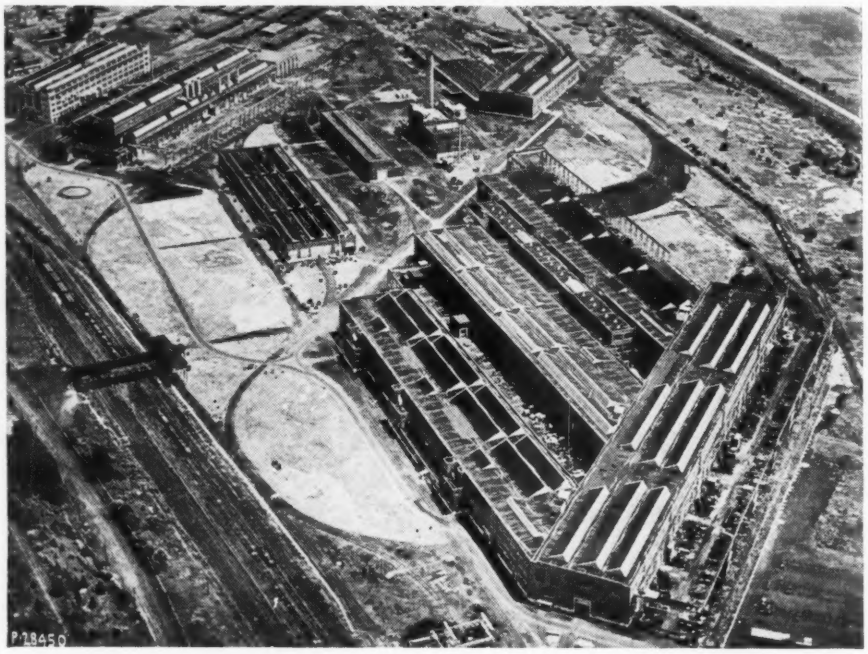
Edward G. Budd Mfg. Co.: In this plant, responsible for many innovations in manufacture, may be seen railroad-car and automobile-body assembly in various stages of development, depending on the production schedule existing at the time. Those inter-

ested in the adaptation and use of stainless steel will find many ingenious applications of that material in the products developed in this plant.

Link Belt Company: One of the pioneers and present leaders in the field of handling materials mechanically and transmitting power positively since 1875 when William D. Ewart, the inventor of the Ewart detachable link belt, founded the Company. In this plant, in addition to the manufacture and assembly of variable-speed and speed reducers of various types, may also be seen the practical development and application of the Taylor System of Scientific Management which was introduced in 1905 under the personal direction of Frederick W. Taylor who conceived the idea.

Trip 2

General Electric Switchgear Works: This is the largest switchgear manufacturing plant in the world. Here steel is used extensively in the building of modern switching equipments. The inspection trip will cover items of particular interest to mechanical engineers, including: Steel fabrication on a progressive basis for sheets and light structures, resistance and arc welding of all varieties, paint spray booths using the largest water-wash processes, and alloy foundry for nonferrous metals.



WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, SOUTH PHILADELPHIA WORKS

Wednesday morning, Dec. 6

Trip 3

Baldwin Locomotive Works and Baldwin-Southwark Corp.: The Baldwin Locomotive Works and its subsidiaries (including Baldwin-Southwark Corporation and the Cramp Brass and Iron Foundries) are situated on a level tract of 520 acres. The shops, exclusive of offices, have a total floor space of 103.5 acres or 4,500,000 square feet. The number of employees, during the last few years, has varied between 3000 and 6000. The principal products are steam, electric, Diesel, and mine-electric locomotives; stationary Diesel engines; large hydraulic turbines; a wide range of hydraulic presses; hydraulic-testing machines; ship propellers and marine castings; large hydraulic valves; Diesel-engine frames; and locomotive castings.

Trip 4

Curtis Publishing Company: Here will be seen the most modern processes required for printing the *Saturday Evening Post. The Ladies Home Journal,* and *The Country Gentleman.* Of special interest is the new Curtis 4-and-4 precision color processes by which 4 colors can be printed on both sides of a fast-moving sheet of paper requiring no time interval for drying the different colors.

The Beck Engraving Company: This company makes plates for color prints for the *National Geographic,* for covers of *The Saturday Evening Post, Ladies Home Journal,* and various other magazines.

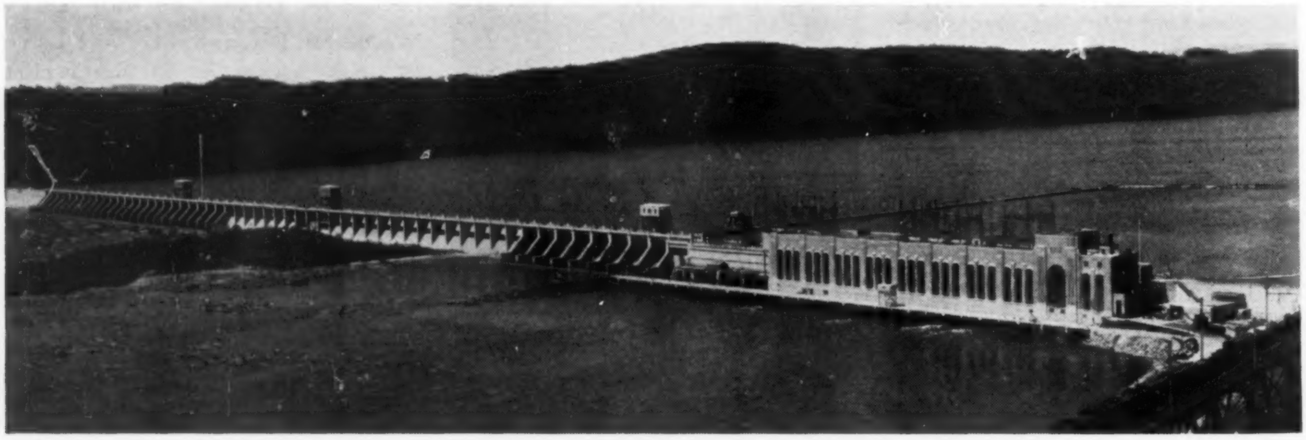
Trip 5

Schuylkill Generating Station—Philadelphia Electric Co.: During 1938 a 50,000-kw, 3600-rpm turbogenerator, designed for 1250 lb pressure, 900 F total temperature, and exhausting against a back pressure of 250 lb was installed. Two 600,000 lb per hour pulverized-fuel-fired boilers generating steam at 1350 lb pressure and 910 F total temperature supply the turbogenerator. Efficient modern auxiliary equipment completes the installation.

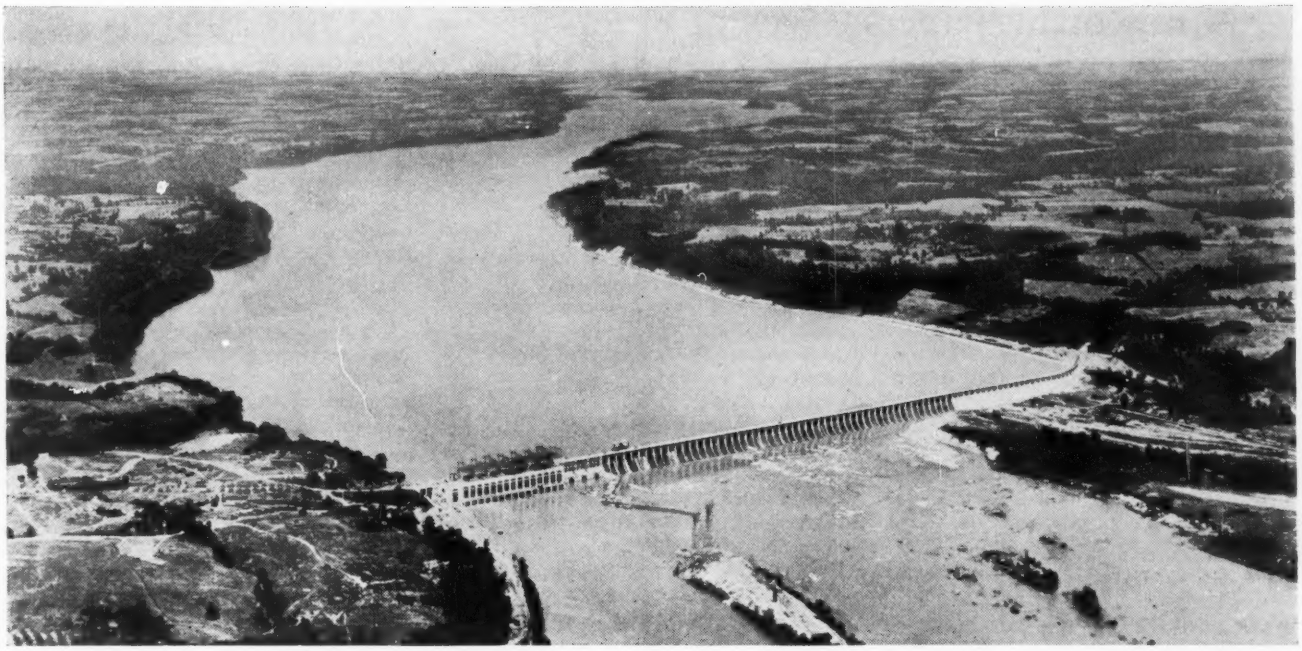
Wednesday afternoon, Dec. 6

Trip 6

Westinghouse Electric & Manufacturing Company: At this plant turbines of all sizes, gears, condensers, pumps, ejectors, high-speed forced-draft blowers, and lighting sets are built. This plant affords the opportunity of seeing the manufacture of turbines in their various stages, as well as complete assembly and test of turbines and auxiliary equipment. The experimental laboratory contains a number of machines used for experimental and development purposes, particularly those problems relating to thermodynamics, aerodynamics, and hydrodynamics. The mechanical laboratory contains many modern testing machines, including equipment for long-time tests to determine the behavior of metals when exposed to high temperatures.



SAFE HARBOR HYDROELECTRIC DEVELOPMENT



CONOWINGO HYDROELECTRIC PLANT

Trip 7

SKF Industries, Inc.: This is one of the most modern plants for the production of antifriction bearings. All types and sizes of ball and roller bearings are manufactured from the raw material to the finished product by some of the most skilled craftsmen in their line. Nearly one tenth of the manufacturing space is allotted to inspection . . . an indication of the extreme care which is exercised. The assembly and final-inspection departments are completely air conditioned.

Philadelphia Gear Works: Here are manufactured speed reducers and increasers, valve controls, and all types of industrial gears up to 16 ft in diameter—spur, bevel, helical, and herring-bone. All kinds of metallic and nonmetallic materials are employed. The factory is equipped with the very latest in machines for gear manufacture, among which the flame-hardening equipment will be of especial interest.

Thursday morning, Dec. 7

Trip 8

Sun Oil Company, Marcus Hook Refinery: This refinery is one of the largest and most modern refineries in this part of the country. Here will be seen processes starting with raw crude and progressing through to the finished lubricating oil or gasoline. The inspection trip will cover pipe stills and equipment, the famous mercury-vapor processes for obtaining lubricating oil, thermal cracking for gasoline production, and the new and interesting Houdry catalytic processes. A Velox steam generator and a gas turbine are in operation here.

Thursday all day, Dec. 7

Trip 9

Conowingo and Safe Harbor Hydroelectric Plants: This trip, especially for hydraulic engineers, should be one of the most attractive of the inspection trips. It will afford an opportunity to inspect, at first hand, two of the nation's outstanding hydroelectric developments. The Conowingo hydroelectric plant, located 65 miles from Philadelphia near the mouth of the Susquehanna River, has a rated capacity of 338,000 hp. Additional installations will bring this figure up to 531,000 hp. Thirty-eight miles further up the river is the Safe Harbor hydroplant with a rated capacity of 255,000 hp and a future capacity of 510,000 hp.

Thursday afternoon, Dec. 7

Trip 10

Leeds & Northrup Co.: This plant offers an opportunity to see a wide variety of operations in the manufacture of laboratory and plant instruments, furnaces, and controls . . . a combination of semi-mass-production methods and highly skilled craftsmanship.

Brown Instrument Co.: This trip will consist of an inspection of the engineering and production departments of this company, which manufactures industrial measuring and controlling instruments for boiler rooms and all industrial processes. The instruments shown will include electrical pyrometers, thermometers, pressure gages, CO_2 recorders, flow meters, resistance thermometers, and tachometers.

Trip 11

Sun Shipbuilding and Dry Dock Company: At this plant will be seen the varied activities essential to modern shipbuilding. Here there is being built cargo ships, oil tankers, and large marine-Diesel-engine vessels. This plant is one of the country's most modern shipbuilding plants and has a capacity to deliver as much deadweight tonnage on cargo and oil tankers as any yard in this country. Visitors will see ships under construction, ships at fitting-out piers, and vessels in dry dock, and will have an opportunity to visit the various shops.

BALDWIN-SOUTHWARK PLANT, EDDYSTONE, PA.

Noteworthy Papers Given at Meeting of Wood Industries Division

Dr. Hugh P. Baker and H. S. Jones Speakers at Banquet; C. B. Norris Elected New Chairman

C. B. NORRIS
(Elected Chairman of Executive Committee.)

ONE of the most interesting technical programs ever arranged by the A.S.M.E. Wood Industries Division was presented at its national meeting held in Boston, Mass., October 12 and 13.

At the first technical session, Thursday morning, three papers were presented, the first of which, dealing with the hardwood-dimension industry, was presented by Louis J. Bosse, managing director, Hardwood Dimension Manufacturing Association, Louisville, Ky. J. W. Medley, technologist in wood products of the National Bureau of Standards, in his paper pointed out the possibility of cooperation by the Wood Industries Division in a general program of dimensional limits and tolerances in the wood industry. The third paper on modern timber construction by Conrad Pantke of Roof Structures, Inc., New York, N. Y., explained the most recent developments in the technique of applying connectors and laminated wood in that field.

Banquet Held With Boston Section

The annual banquet of the Division was held in conjunction with the Fall Meeting of the A.S.M.E. Boston Section at Walker Memorial Building, Massachusetts Institute of Technology, Prof. Edgar McNaughton, chairman of the Boston Section, welcomed the members of the Division and R. H. McCarthy, chairman of the Division, responded.

The address of the evening was delivered by Dr. Hugh P. Baker, president of Massachusetts State College, on "A Program for More Effective Cooperation Between the Woodworking Industries and the Education of Engineers," while a technical paper dealing with "A Plan of Foremanship Training" was presented by Henry S. Jones, production engineer, Globe Wernicke Co., Cincinnati, Ohio.

At the second technical session, Friday morning, one of the first technical papers to be prepared in this country on the subject of plywood compressed to density above normal, "Super-Pressed Plywood," by R. K. Bernhard, T. D. Perry, and E. G. Stern was presented. Dr. Bernhard is head, and Mr. Stern, a registered architect, research assistant, of the department of engineering mechanics of The Pennsylvania State College; Mr. Perry is woodworking engineer in charge of market development, The Resinous Products and Chemical Co., Philadelphia, Pa. Many interesting possibilities are opened by this development because it will permit the use of wood for higher loads with a greater degree of precision than has been possible heretofore.

Also presented at this session was a paper by John E. Burchard, director of the A. F. Bemis Foundation at the Massachusetts Institute of Technology, on "Economic Factors of the Housing Problem" in which he pointed out certain conclusions reached with reference to the possible extent of a housing program and the significant factors controlling it. Mr. Burchard's paper appeared as the leading contribution to the November issue of MECHANICAL ENGINEERING.

At a luncheon meeting of the Executive Committee of the Division reports were received from the newly organized subcommittees of the Division as follows: Sern Madsen on Dimensional Limits and Allowances, M. J. MacDonald on Wood Finishing, and T. D. Perry on Adhesives and Plywood. Each of the subcommittees has developed a program of considerable interest which will require continuous effort. C. B. Norris, of R. F. Lauche, Inc., Lockport, N. Y., was elected chairman of the Executive Committee of the Division for 1940.

Inspection Trips

Of particular interest to those in attendance at the meeting was the series of plant-inspection trips arranged for the afternoons. These included the S. A. Woods Machine Company, who manufacture new high-speed molders and matchers; the Atlas Plywood Company where the shipping-container laboratory and tests, and the new no-nail box assembly were seen; and the Simonds Saw and Steel Company, which is a unique windowless plant giving standardized working conditions for twenty-four-hour operation.

Robert H. Thurston, First President of A.S.M.E., Honored on Hundredth Anniversary of His Birth

Society Joins With Cornell University and Others in One-Day Centennial Celebration on Oct. 25 at Ithaca, N. Y.

REPRESENTATIVES from technical societies in England, France, Germany, and Canada were among the delegates from more than sixty organizations and educational institutions which took part in the celebration of the hundredth anniversary of the birth of Robert Henry Thurston, first president of the A.S.M.E., at Cornell University on October 25. In the audience of more than a thousand persons were distinguished graduates of the Sibley College of Mechanical Engineering at Cornell during Thurston's time, emeritus professors who served with Thurston on the faculty, and three members of the Thurston family, two daughters and a nephew.

A.S.M.E. Representatives

Representing The American Society of Me-

Left to right: DR. J. P. ADAMS, DR. W. F. DURAND, PRESIDENT EDMUND E. DAY, REAR ADMIRAL WILSON BROWN, AND DEAN S. C. HOLLISTER

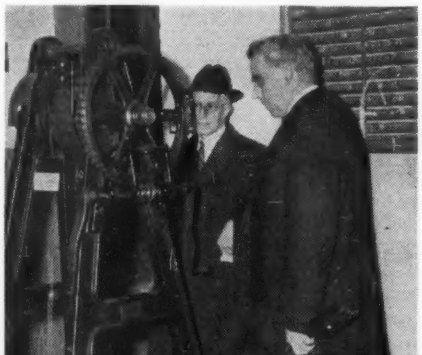
chanical Engineers, which cooperated in the celebration, were President Alexander G. Christie, Past-Presidents Harvey N. Davis, William F. Durand, and Dexter S. Kimball, and Vice-President James W. Parker. Drs. Davis and Durand were speakers at the Centennial Convocation in Bailey Hall, at which President Edmund E. Day of Cornell presided. Other speakers were Vice-President James P. Adams of Brown University, Rear Admiral Wilson Brown, superintendent of the U. S. Naval Academy, and Dean S. C. Hollister of the College of Engineering at Cornell. Dr. Adams spoke of Thurston as an undergraduate, Admiral Brown of his service in the Navy and his teaching career at Annapolis, President Davis of Stevens Institute of his career at that institution, and Dr. Durand of his 18 years as director of instruction in mechanical engineering at Cornell. Dean Hollister applied principles of engineering education enunciated by Dr. Thurston to the problems of the present and the future.

During the convocation Bancroft Gherardi, a student of Thurston at Cornell who recently retired as vice-president and chief engineer of the American Telephone and Telegraph Company, unveiled an oil portrait of Dr. Thurston and presented it to Cornell University. The portrait, by Professor Olaf Brauner, shows Thurston in his later years lecturing before a class. Decorations at the convocation were yellow chrysanthemums, which were Thurston's favorite flowers, always used during his lifetime for decorations on his birthday.

A. G. CHRISTIE, PRESIDENT A.S.M.E., AND A. L. HELWIG LOOKING AT THE CENTENNIAL EDITION OF THURSTON'S "HISTORY OF THE GROWTH OF THE STEAM ENGINE," PUBLISHED ESPECIALLY FOR THE OCCASION BY THE CORNELL UNIVERSITY PRESS

Three Hundred Attend Luncheon

Nearly three hundred delegates, Cornell alumni, and other guests of the University attended a Centennial Luncheon in Willard Straight Hall at the close of the convocation. No speeches were scheduled, but Dr. Day briefly greeted the delegates, introduced members of the Thurston family, and presented Adolphus L. Helwig, president of the American Section of the French Society of Engineers, who brought cordial greetings direct from France and recalled that Dr. Thurston had been not merely an honorary member, but an active member of the French society, exchanging technical information with its members and offering suggestions on policy and organization.



DR. HARVEY N. DAVIS AND DEAN S. W. DUDLEY INSPECT THURSTON TORSION-TESTING MACHINE

Thurston Exhibition

During the day Cornell exhibited a comprehensive selection of Thurston's publications, featuring the centennial edition of "The History of the Growth of the Steam Engine," especially published for the occasion by the Cornell University Press; a series of historical photographs showing the development of engineering at the University during and since Thurston's time; and several pieces of laboratory apparatus and research material showing Thurston's skill in design and in scientific inquiry. Preparations are already under way for the publication of a memorial volume including the speeches at the convocation and a list of the delegates.

Engineering Foundation Elects New Officers

FOLLOWING a meeting of the Engineering Foundation last month, Prof. George Erle Beggs of Princeton University was elected chairman of the Foundation, research organization of the national engineering societies. O. E. Buckley, executive vice president of the Bell Telephone Laboratories, New York, was chosen vice-president. Otis E. Hovey was reelected director, and John H. R. Arms was again named secretary.

The executive committee is headed by Professor Beggs as chairman. Other members are: F. F. Colcord, vice-president of the U. S. Smelting, Refining, and Mining Company, New York; Kenneth H. Condit, executive assistant to the president, National Industrial Conference Board; A. L. J. Queneau, metallurgist of the U. S. Steel Corporation, New York; and Mr. Buckley.

Dean A. A. Potter of the Purdue University School of Engineering, and H. R. Woodrow, vice-president of The Consolidated Edison Company of New York, were appointed to the Foundation Board. Dean Potter represents The American Society of Mechanical Engineers, and Mr. Woodrow, the American Institute of Electrical Engineers.

Woman's Auxiliary to A.S.M.E. Establishes Rice Scholarships

THE November meeting of the Metropolitan Section Woman's Auxiliary to the A.S.M.E. was held on Nov. 9 at the Engineering Woman's Club in New York City. A National Board meeting in the morning preceded the Section session in the afternoon. The Board members passed a resolution authorizing the Auxiliary to add $200 from its funds to the $200 already in the Calvin Winsor Rice Scholarship Fund. Thereupon, Mrs. Rice made a contribution of $100 in memory of Mr. Rice, thus making it possible to award this year the first Rice Scholarship to a deserving South American student in mechanical engineering which will make it possible for him to complete a postgraduate course in some American engineering college. Friday evening, Nov. 10, the Ways and Means Committee for the Auxiliary started the ball rolling for the second Rice Scholarship by sponsoring a dinner for the Fund. It is expected that this second scholarship will be available two years hence.

More Than 500 Turn Out for Metropolitan Section Meetings to Hear Engineering Congress Papers

F. C. Horner Discusses Problems of the Highway User and Merchant-Ship Design and Operation Is Described by R. C. Lee

TWO of the four American papers scheduled for presentation at the British American Engineering Congress, which was to be held in New York City, Sept. 4–8, 1939, but had to be canceled because of the European War, were presented before more than 500 A.S.M.E. members and guests in October and November under the auspices of the Metropolitan Section and other organizations.

Highway Users

The first paper, "Problems of the Highway User in the United States," was given by Frederick C. Horner, assistant to the chairman, General Motors Corp., before an audience of 200 assembled in the auditorium of the Engineering Societies Building on Oct. 31. Cooperating in the meeting was the Metropolitan Section of the A.S.C.E. Thomas H. MacDonald, U. S. Commissioner of Public Roads, served as chairman of the session.

Merchant Ships

"Some Problems in the Design and Operation of Merchant Ships," covering the technical aspects of ship design and operation from the viewpoint of executive administration of the merchant marine, was the subject of the second paper, which was presented before 350 by Robert C. Lee, executive vice-president, Moore-McCormack Lines, Inc., on Nov. 9 at Stevens Institute of Technology, Hoboken, N. J. Rear Admiral George H. Rock, U. S. Navy (retired), was the presiding officer. Prior to the meeting, Prof. K. S. M. Davidson demonstrated the Stevens model test towing tank. The session was conducted in conjunction with the Stevens Engineering Society.

High-Speed Lightweight Trains

At the time of going to press, final arrangements were being completed for C. T. Ripley, chairman of the A.S.M.E. Railroad Division, to give his paper, "High-Speed Lightweight Trains," the third of the group of four, before the Metropolitan Section on Nov. 21. Roy V. Wright, past-president A.S.M.E., was asked to be chairman of the session. The fourth paper, "The Trend of Air Transportation," by Edmund T. Allen, director of aerodynamics and flight research, Boeing Aircraft Company, Seattle, Wash., will be presented in the near future, probably before one of the West Coast Local Sections of the A.S.M.E.

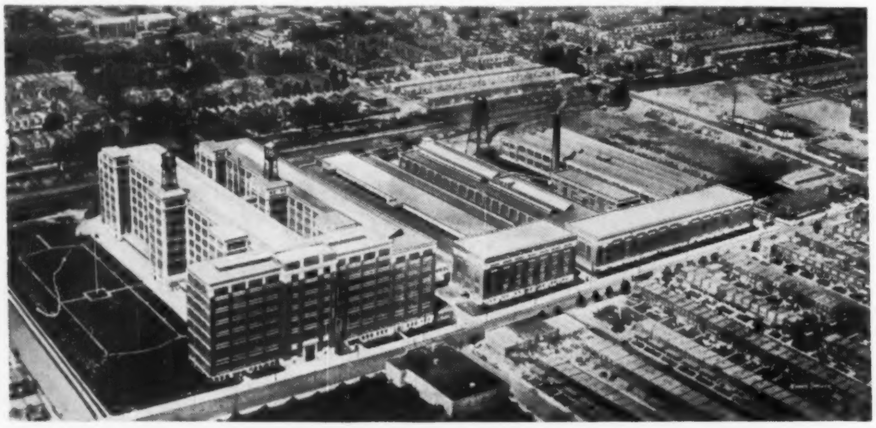
Each of these papers will be published together with discussions at a later date in A.S.M.E. Transactions. Those members who did not or cannot attend the meetings and who would like to read, and possibly discuss, the papers may obtain preprints now upon written request to A.S.M.E. headquarters.

Anthracite-Lehigh Valley Holds October Meeting in Allentown

The second regular meeting of the Anthracite-Lehigh Valley Section for this year was held on Oct. 27 in Allentown, Pa. An audience of 144 turned out for the occasion which featured one paper on "Pulverization," by R. C. Newhouse, chief engineer of crushing and grinding division, Allis-Chalmers Manufacturing Co., and another paper, "Direct Firing of Kilns," by R. M. Hardgrove, engineering-design department, Babcock & Wilcox Co.

Baltimore Section Session on Oct. 11 Draws 75

An audience of 75 members and guests of the Baltimore Section gathered at the Engineers' Club on Oct. 11 to hear L. A. Hawkins, manager of the research laboratory, General Electric Co., talk on "The Significance of Research and Its Relation to Engineering." He described the various kinds of research and how they apply to engineering.



PHILADELPHIA WORKS OF GENERAL ELECTRIC COMPANY TO WHICH TRIP IS PLANNED DURING 1939 ANNUAL MEETING

Licensing Law Explained to Members in Birmingham

Dr. John M. Gallalee, of the University of Alabama, spoke before the Birmingham Section on Sept. 29 about the changing conditions in the practice of engineering, explaining how the new agencies and laws reflect the changing attitude of the public and the profession toward the individual engineer. Proposed amendments to the Alabama licensing law were discussed.

Buffalo Section Has More Than 200 at Two Meetings

More than 150 members and guests of the Buffalo Section assembled on the evening of Sept. 26 to listen to a paper on "The Development of the Carbon Microphone," which was presented by Dr. Goucher, Bell Telephone Laboratories. The meeting of Oct. 6, attended by about 75 members and visitors, featured a talk by C. W. Smith, Lincoln Electric Co., on "Arc-Welded Structures and Machinery."

Kokomo Is Scene of Oct. 20 Meeting of Central Indiana

The story of Haynes "Stellite" and its application in mechanical engineering was presented before 50 members and 25 guests of the Central Indiana Section by E. E. LeVan, vice-president, Haynes Stellite Co., at the Oct. 20 meeting in Kokomo. Prior to the talk, Glenn Hillis gave a brief and interesting sketch of the life and accomplishments of Elwood Haynes, engineer and inventor.

Plastics Discussed Before 50 Cincinnati Members and Guests

D. J. O'Conor, president of Formica Co., was the speaker at the Oct. 26 meeting of the Cincinnati Section, attended by 50 members and guests. The lecture on plastics was confined to the synthetic resins, whose derivation was explained with the aid of a chart. Advantages and practical applications of different resins were discussed, and samples shown.

Cleveland Members Hold Dinner and Meeting in Industrial Plant

The first regular meeting of the Cleveland Section was held on Oct. 12 at the General Electric Company's plant in Nela Park. Preceding the regular program, a sumptuous banquet was served to 44 members and guests in the Nela Park dining room. The meeting featured talks on the latest improvements in automotive lighting and industrial lamps. The first lecture, on the new sealed-beam headlight, presented by K. D. Scott, was staged in the automotive lighting laboratory of the plant where actual lighting conditions can be simulated and demonstrated. The second

paper, a discussion of modern industrial lighting, was given by A. K. Gaetjens. Many innovations and improvements in methods of illumination for various jobs were demonstrated. Two new shop spotlights, of the same construction as the sealed-beam headlight, were among the items shown.

65 Columbus Engineers Make Inspection Trip to Dairy

An inspection trip was made by 65 members and guests of Columbus Section on Oct. 20 to the Moores and Ross Dairy where the latest developments in milk conditioning and bottling were shown and described by Bernard Spavey, chief engineer.

400 Attend Detroit Meeting on Turbine-Electric Locomotive

About 400 members and guests of the Detroit Section attended the Nov. 14 meeting at The Detroit Edison Building. The meeting was preceded by a dinner, music, and a motion picture describing travel by air. After the Greetings Committee had made everyone feel

C. M. DAVIS

at home, the speaker of the evening, C. M. Davis, transportation engineer, General Electric Co., Erie, Pa., was introduced. His talk, entitled "The Union Pacific Turbine-Electric Locomotive," was based on a paper by A. J. Woodward and B. S. Cain, which appeared in the October and November issues of Mechanical Engineering.

Newly Formed Fort Wayne Section Holds First Meeting on Oct. 5

The newly formed Fort Wayne Section of the A.S.M.E., Prof. Norman T. Bourke, chairman, held its first meeting on Oct. 5. A very interesting discussion on the economy of computing gasoline pumps took place. The next meeting of the Section, scheduled for Nov. 9, featured a discussion on "Modern Developments in Transportation Engines." It is with regret that the Section accepts the loss of its secretary, Willard Connor, who is leaving to follow his first love, aeronautical engineering, to the West Coast. But his place will be ably filled by Frank McInerney. Committee chairmen of the Section are Frank C. Mason, program; F. W. Avilla, division activities; Frank McInerney, publicity; W. E. Johnson, professional activity; and C. L. Parker, student activity.

THE SKF FACTORY IN PHILADELPHIA TO WHICH TRIP IS PLANNED AT 1939 ANNUAL MEETING

Ithaca Section Takes Part in Thurston Centennial

More than 30 members of the Ithaca Section took part in the Thurston Centennial celebration on Oct. 25, which was held under the joint sponsorship of the A.S.M.E. and Cornell University. Further details will be found on pages 934–935.

Kansas City Section Offers Prizes to Student Members

At the executive-committee meeting of the Kansas City Section on Sept. 22, it was voted to offer a prize of a year's membership dues ($10) for each of the following: (1) The best paper by a student member at Kansas State College Branch; (2) the best paper by a student member at Kansas University Branch; and (3) the best paper by a junior of the Kansas City Junior Group. The inspection trip of the Section on Oct. 6 to the plant of the Sheffield Steel Corp. was attended by more than 130 members and guests.

Vibration in Engineering at Louisville Section

Highly recommended by the Louisville Section as a speaker for other Local Sections of the A.S.M.E. is T. C. Rathbone, chief engineer, turbine and machinery division, Fidelity and Casualty Insurance Co. His talk, "Vibration in Engineering," on Oct. 17 was the best yet presented before the Section. Types of vibrations, from cosmic rays to rolling ships, were described and demonstrated by models. Modern methods of balancing, vibration studies, and checking for fatigue cracks in machinery were also discussed.

Two Interesting Papers at Los Angeles Oct. 12 Meeting

Before 114 members and guests of the Los Angeles Section, meeting at Barker Bros. on Oct. 12, Guy M. Wadsworth discussed "Hiring for Good Labor Relations," and Dr. Norton B. Moore described "Present Trends in Airplane Design."

Mid-Continent Section Sponsors Student-Member Session in December

Max R. Wise, secretary of the Mid-Continent Section has mailed invitations to the A.S.M.E. Student Branches at the University of Arkansas, Oklahoma A.&M. College, and University of Oklahoma, and the A.I.M.E. branch at Tulsa University, to send representatives and one speaker each to a Student Meeting on Dec. 12 which will be sponsored by the Section. Each speaker will be given a souvenir, such as pocket slide rule or a pencil.

Noon Meeting of Nebraska Attracts Audience of 200

Dr. William M. Barr, chief metallurgical and chemical engineer, Union Pacific R. R., spoke on Oct. 4 at a noon meeting arranged by the Nebraska Section before 50 members and 150 students. His topic was "Research and the Railroads."

New Haven Section Holds First Meeting on Oct. 25

As the feature for the first meeting of the year held on Oct. 25 at the Yale Graduate Club by the New Haven Section, Prof. Alan M. Bateman described a trip he took, in his capacity of geologist, from Alaska by steamboat to England, and from there by airplane to Central Africa.

Military Mechanization Discussed at North Texas

On Oct. 30, North Texas Section presented Lieut-Col. J. M. Thompson as the guest speaker. His subject was "Military Mechanization." He showed how procurement standardization and mechanization depends on the cooperation of mechanical engineers and automobile manufacturers.

Ontario Section Holds Pressure-Vessel Session

Harry Blumberg, M. W. Kellogg Co., presented a paper on "Special Alloy Linings for Pressure Vessels" before the Ontario Section at its Oct. 12 meeting. The paper was devoted to the general subject of fabrication and maintenance of the various types of alloy linings

used in clad vessels, and discussed the problems from an economic and engineering point of view.

Philadelphia Has Largest Turnout for Meeting in Recent Years

The S.R.O. sign was hung out at the Oct. 24 meeting of the Philadelphia Section which was held at the Engineers Club. E. A. Hodge, marine manager, Pusey & Jones Corp., presented a paper on "Trends in Power Equipment for Ships" to a sell-out audience. There were 115 men present for the dinner preceding the meeting and 350 for the technical session. This is by far the largest group for either the dinner or the meeting in recent years, reports Secretary-Treasurer J. S. Morehouse. Discussions were given by T. B. Stillman, Babcock & Wilcox Co., E. Davis, Westinghouse Electric & Manufacturing Co., and L. M. Goldsmith, Atlantic Refining Co.

130 Members and Guests at Plainfield Section Meeting

On Oct. 27, before 130 members and guests of the Plainfield Section, Horace A. Staples, vice-president, Phelps-Dodge Corp., presented a sound motion picture entitled, "Copper From Mine to Market."

President Christie Addresses Carolina Students and Members

On the afternoon of Oct. 18, President A. G. Christie gave a talk to a combined meeting of student members from Duke University and North Carolina State College. He called attention to the many opportunities which lie ahead of the engineering profession. Later in the day after an excellent dinner built around the famous steaks served in the Duke Union, Professor Christie spoke on "A Challenge to Engineers" before members of the Raleigh Section.

Rockford Session of Rock River Valley Attracts 250

Rock River Valley Section "the best little Local Section of the A.S.M.E.," is still living up to the compliment paid to it last year by the Program Makers Bulletin. At its Oct. 13 meeting in Rockford, an audience of more than 250 came to hear John A. MacDonald talk about "Behind the Scenes in Tool Design," and Dr. John J. Caton, director of Chrysler Institute of Technology, describe "Behind the Scenes in Engineering."

Illinois Oil Fields Discussed at St. Louis Dinner Meeting

Dorsey Hager, consulting geologist, Centralia, Ill., told a dinner meeting of the St. Louis Section about developments in the Illinois oil fields, including progress, drilling methods, and their relation to the petroleum industry in general.

King Hathaway Talks Before San Francisco Members

"Principles and Practices of Scientific Management" was the subject of the paper presented by King Hathaway before members of the San Francisco Section at the Oct. 26 meeting. He deplored the great publicity given the subject some years ago which led to an epidemic of efficiency engineers who did more harm than good by unethical practices. An outline of requirements of true scientific management was then given.

Memories of World War Days at Susquehanna Meeting

The history of the engineering behind the "Paris Gun" was told by E. T. P. Neubauer at a meeting of the Susquehanna Section in York, Pa., on Oct. 24. He described the birth of the design, the development of the gun and shells for it, and the method of firing the gun.

Subject of Aluminum Discussed Before 100 Worcester Engineers

Since a poll of members at the beginning of the year indicated a great deal of interest in lightweight metals, Worcester Section arranged a meeting on Nov. 6 devoted to aluminum. P. V. Faragher, Aluminum Co. of America, described to 100 engineers the manufacture of aluminum and its alloys. After showing an interesting film, "Aluminum," he answered many questions covering every phase of aluminum production and application.

225 Washington, D. C., Members and Visitors at Ordnance Meet

Taking as the title of his paper, "Recent Developments of Ordnance Material," Lieut-Col. G. M. Barnes described to 225 members and guests of the Washington, D. C., Section on Oct. 5 the new Garand rifle, the various types of mechanized equipment, and other ordnance material. Motion pictures of mechanized cavalry in action were also shown.

Western Washington Discusses Seattle Transportation Means

With officials of Seattle considering the various types of equipment for the city's transportation modernization program, the Western Washington Section did its part by sponsoring a meeting on Oct. 19 at which E. E. Kearns, transportation expert, discussed the various advantages and disadvantages of the various types of equipment available for urban transportation.

Glass Session Held by Toledo Section on Oct. 5

The Toledo Section arranged a glass session for its meeting on Oct. 5. U. E. Bowes, director of research, Owens-Illinois Glass Co., discussed "What Science Is Doing for the Glass Industry." The talk was followed by the showing of a motion picture on the manufacture and applications of glass.

Junior Group Activities

Juniors to Participate in 60th Annual Meeting General Session and Luncheon With Students

JUNIORS of the A.S.M.E., beside taking part in the entire 60th Annual Meeting of the Society in Philadelphia, Dec. 4–8, 1939, will be given an opportunity to attend a general session and a luncheon with student members on Wednesday, Dec. 6. For the session, the Philadelphia Junior Group has designated Zachary Wobensmith, Junior A.S.M.E., to discuss "A Few Points the Engineer Should Know About Patents." The Metropolitan Junior Group will be represented by Leslie F. Zsuffa, Junior A.S.M.E., who will describe the "Problems of the Young Engineer." The third paper at this session, entitled "Our Industrial Destiny," will be presented by Hamilton R. Disston, vice-president, L. H. Gilmer Co., Philadelphia, Pa.

At the luncheon, John I. Yellott, Junior A.S.M.E., and assistant professor at Stevens Institute of Technology, will be given the Pi Tau Sigma Award as the "outstanding young mechanical engineer of 1939." Short talks are to be presented by President A. G. Christie and President-Elect Warren H. McBryde.

Philadelphia Group Starts With Meeting and Trip

THE Juniors of the Philadelphia section opened the new season with a meeting on Oct. 11. Enthusiastic members numbering 45 were entertained with a talk by V. H. Jones, personnel manager for the Philadelphia Electric Company. He explained what his company looks for and what they get when hiring young engineers.

This meeting was followed by a trip on Oct. 18 to the broadcasting studios of station WFIL, located at the Widner Building on Chestnut St. in Philadelphia. The 20 members who attended this trip found many things of interest, particularly the electrical-transcrip-

tion devices. From the enthusiasm shown at the first meeting and trip, the Group is looking forward to a very successful season.

Chicago Juniors Have Discussion on Local Educational Facilities

"EDUCATIONAL Opportunities in the Chicago Area" was the subject of the program presented by the Chicago Junior Group on Oct. 24 before 35 members and guests. The symposium was led by J. S. Kozacka and Dr. Christian Bay, librarian of the John Crerar Library of Chicago. All phases of the question of facilities in or near Chicago for further study on the part of engineers were thoroughly discussed.

Cleveland Juniors Inspect Automotive-Parts Factory

ON October 25, an inspection trip, arranged by the Cleveland Junior Group and attended by about 35 Juniors and Student Members from the Case School of Applied Science, was conducted through the plant of the Thompson Products, Inc., manufacturers of valves, valve guides, pistons, wrist pins, bushings, and other automotive and aircraft parts.

This plant is built along mass-production lines and was going full blast at the time. Large numbers of automatic and semiautomatic machines were in operation, together with many special jobs. Of special interest were the methods and machinery used for producing poppet valves, such as are used in an automobile engine.

Los Angeles Junior Group Has Meeting and Inspection Trip

THE Los Angeles Junior Group members, numbering 40, held their Oct. 9 meeting at the plant of Sterling Electric Motors. Bernard Palm gave an illustrated lecture on the manufacture and application of various types of electric motors. Much interest was shown in the variable-speed drive. An inspection trip through the plant concluded the program.

Kansas City Juniors Learn About Air Conditioning and Fire Fighting

SPEAKING first at the Oct. 10 meeting of the Kansas City Junior Group was Leonard Fieman whose topic was "Experimental Air Conditioning Apparatus at the University of Illinois." The unit was designed for year-round air conditioning and includes the latest types of materials of construction, filters, spray nozzles, and cooling and heating coils. Next on the program was Bob Rupley, and his paper on "Fire Protection for Oil-Filled Transformers." Citing various instances where damaging fires occurred, the speaker indicated that only a few years ago protection was generally inadequate to prevent serious loss when fire broke out. Recently two new methods have been perfected which seem to be quite satisfactory.

The first method is represented by the fog-nozzle type, which works on the principle that when a nozzle converges to form a homogeneous vapor phase, the vapor pressure of the burning oil is reduced, and it is cooled below the ignition point. By arranging nozzles around the transformer and placing in the water-supply line a thermostatic control, the fire may be put out in less than thirty seconds from the time the control operates. A water pressure of fifty pounds is desirable. The second method is represented by the emulsifier system. In an ordinary oil-water emulsion the oil is the internal phase and is coated by the water as the external phase. Projectors are precision made and spray the water into the oil, causing an emulsion to be formed and thus removing the oil from contact with oxygen. This system can use lower water pressure than the fog system. Underwriter's laboratory tests indicate that either method will put out a fifty-gallon oil fire in less than fifty seconds.

With the Student Branches

Hundreds of Student Members to Take Part in A.S.M.E. Annual Meeting in Philadelphia

Wednesday, Dec. 6, Designated as Student Day, and Will Include General Session, Luncheon, and Plant Trips

STUDENT MEMBERS of the A.S.M.E. from colleges and universities in all parts of the United States and Canada plan to attend the Society's 60th Annual Meeting in Philadelphia on Wednesday, Dec. 6, which has been set aside by the Committee on Meetings and Program as Student Day. An especially large attendance is expected from schools situated within a hundred miles of the City of Brotherly Love. Many student members in and near Philadelphia have already volunteered their services as ushers and assistant recorders for the 33 technical sessions which start on Monday evening.

It has been the custom in past years for schools to excuse all mechanical-engineering students from classes during the week of the A.S.M.E. Annual Meeting so that they might attend not only the regular sessions, but the Student Day functions also. This year's program promises to be the best yet held for students at an annual meeting. Following is an outline of the program for Wednesday, Dec. 6:

Student Day Program

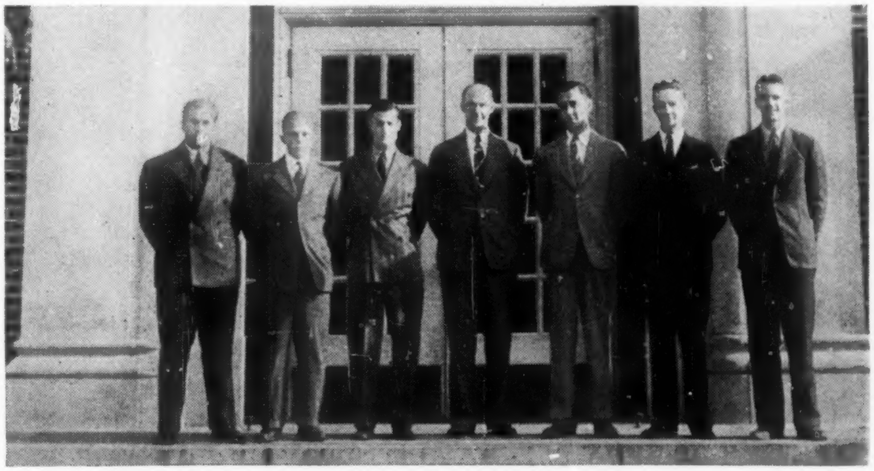
9:30 a.m.

General Session

A Few Points the Engineer Should Know About Patents, by Zachary Wobensmith, patent attorney, Philadelphia, Pa.

Problems of the Young Engineer, by Leslie F. Zsuffa, A.S.M.E. staff member, New York, N. Y.

Our Industrial Destiny, by Hamilton R. Disston, vice-president, L. H. Gilmer Co., Philadelphia, Pa.



PRESIDENT CHRISTIE AND PURDUE STUDENT OFFICERS

(Photograph taken upon the occasion of his visit to the Branch on October 5, 1939.)

12:30 p.m.

Student Luncheon

Toastmaster: Prof. F. V. Larkin, Lehigh University, chairman of Committee on Relations With Colleges.

Speakers: Dr. Harvey N. Davis, past-president A.S.M.E., and president, Stevens Institute of Technology (he will present recipient of Pi Tau Sigma Award); John I. Yellott, junior A.S.M.E., and assistant professor, Stevens Institute of Technology (recipient of Pi Tau Sigma Award for 1939); Prof. A. G. Christie, President of the Society; and Warren H. McBryde, president-elect of the A.S.M.E.

Guests to Be Introduced: James R. Bright, 1939 Charles T. Main Award recipient; David T. James, 1939 Undergraduate Student Award winner; and Harte Cooke, chairman of the Board of Honors and Awards.

2:00 p.m.

Plant Trips

Special buses will be available for student members for plant trips listed on pages 931–933.

6:30 p.m.

Annual Dinner

Recipients of Charles T. Main and Undergraduate Student Awards and official representatives of Student Branches will be guests of the Old Guard Committee at the Annual Dinner.

Branch Meetings

Arizona's Outstanding Engineers

PLANS for an exhibit at the annual engineers' dance were discussed at the Oct. 5 meeting of the ARIZONA BRANCH. These exhibits are a regular feature of this affair which is sponsored by the student branches of the Founder Societies. It was revealed at the meeting that a plaque containing the names of outstanding mechanical engineers will be hung in the mechanics laboratory. Names of two graduates, Robert Q. Parsons, '37, and Frederick B. Clark, '38, have already been chosen for the plaque.

860 at Armour Meeting

Records were smashed by ARMOUR BRANCH for attendance at meetings when 860 members and guests attended the Oct. 18 meeting in the school's auditorium. The guest speaker was Dr. Martin Graubau, of the Polaroid Corporation, who lectured on "Polarized Light." The talk was illustrated with slides and special stereoscopic pictures in color.

AUBURN BRANCH showed a three-reel movie on the production, operation, and maintenance of a Caterpillar Diesel tractor during its Oct. 2 meeting. At the Oct. 30 meeting, Lieut. B. M. Cornell, of the aeronautics department, described the functions of the C.A.A.

At BRITISH COLUMBIA BRANCH on Oct. 4 a paper on "Ore Chutes" was presented by student member Keith Eadie. Chairman Roy Bogle, at the Oct. 25 meeting, explained to the members the possibilities of the mechanical engineers' library.

BROWN BRANCH held its first meeting on Oct. 31. The members present voted to establish a prize of $5 for the best paper presented by a student member during the year.

CALIFORNIA TECH BRANCH members discussed plans for the coming year at the Oct. 6 session.

Snelling Addresses Catholic Branch

Vice-President H. H. Snelling of the A.S.M.E. was the guest of honor at the Oct. 16 get-together of CATHOLIC BRANCH. He spoke on the aims and objectives of the Society and its benefits to the student and the engineer.

CINCINNATI BRANCH is unique in that it has two chairmen, or cochairmen. They are Harold Gregory and Guy Odom. We've heard of cocaptains of football teams.

AT THE COOPER UNION (EVENING) BRANCH DINNER, NOV. 4, 1939

CLEMSON BRANCH is especially particular about its membership. At the Oct. 5 meeting, only one fourth of eligible juniors were admitted to membership because of a scholarship rule invoked by the Branch. Seniors may become members as long as they are eligible for graduation.

COLORADO BRANCH entertained its 80 members on the evening of Oct. 18 by showing two motion pictures, "Making of Safety Glass" and "Clouds." Both pictures, obtained from the Ford Motor Co., are heartily recommended to other branches.

Colorado Mines Branch Formed

COLORADO MINES BRANCH under the leadership of L. Elkins, as chairman, arranged a visit on Oct. 7 to the Union Station in Denver to inspect the Burlington *Zephyr*. After all the passengers had left the train, the group of 25 members and guests were carried on the *Zephyr* to the roundhouse to see the operations there.

COLORADO STATE BRANCH opened the first meeting of the semester on Oct. 10 with talks by Chairman Lawrence Wilkins and Professor Strate, and closed it with coffee and rolls. What, no doughnuts?

COOPER UNION BRANCH (evening) met on the evening of Oct. 30 to listen to a paper on "Economy Loading Within the Generating Station" given by M. J. Steinberg, Consolidated Edison Co. of New York. The incremental rate method of calculating load division was stated by the speaker to result in the best station loading.

DETROIT BRANCH held its first meeting on Sept. 28. Talks were given by Professor Linsenmeyer and John Schecter, secretary of the Detroit Junior Group.

DUKE BRANCH had its meeting of Nov. 1 opened with the introduction by Chairman Howard O. Schmidt of the guest speaker, Dr. E. Malcolm Carroll, whose subject was "War and the Military Future."

Georgia Tech Members Speak

R. J. Wooddall, chairman of the GEORGIA TECH BRANCH, introduced the student speakers at the Oct. 31 meeting. R. M. Norman described "The Design Trends of the 1940 Autos," and R. A. Oquendo discussed the "Mechanical, Electrical, and Heat-Power Equipment Used in Sugar Mills in Cuba." Ed Hale and Steve Harper, members of the Atlanta Section, were welcomed to the meeting by the 55 student members who were present.

IOWA UNIVERSITY BRANCH holds a meeting every week at which members present papers. During October, according to the fine reports sent in by Corresponding Secretary H. L. Yakish, the speakers were May, Miller, Yakish, Stiller, Kippenham, Horst, Pestal, Hart, Park, and Deddens. Average attendance at the weekly meetings runs around 60.

IOWA STATE BRANCH had an attendance of 87 at its first meeting on Sept. 11.

Johns Hopkins Plans Suds Feast

As explained by Secretary Charles D. Montgomery in his report, sometimes it is necessary for an organization of students, such as the JOHNS HOPKINS BRANCH, to undertake such

affairs as the "Suds Feast" which is to be held in the near future in cooperation with MARYLAND BRANCH. At the meeting of Oct. 25, Charles Depkin and Carl Knabe were appointed by Chairman Charles Flogle to make the arrangements for the affair.

KANSAS BRANCH held a joint meeting with the A.S.C.E. student branch on the evening of Oct. 12. Manley Hood, engineer with the N.A.C.A., gave an illustrated lecture on the wind tunnels used at Langley Field for testing models and full-size airplanes.

Kansas State's Outstanding Student

Before an audience of 200 at the Oct. 19 meeting of KANSAS STATE BRANCH, Professor Brainard presented a set of Kent and Eshbach handbooks to Vincent Ellis, who was selected as the outstanding junior student for 1938-1939. The award was based on scholarship, 50 per cent; personality, 25 per cent; and activities, 25 per cent.

KENTUCKY BRANCH transacted a lot of business and showed two motion pictures on Oct. 6. Titles of the films were "Balloon Racing" and "Ohio Travelogue."

LEWIS BRANCH members at their meeting of Oct. 11 approved the formation of committees to promote the activities for the coming year. Beside the publicity, shop trips, membership, and outside speakers committees, a general committee consisting of the chairmen of last year's committee for the Student Conference held at Lewis was formed for the purpose of assisting this year's host school.

L.S.U. BRANCH decided that the radio in its meeting room had outgrown its usefulness, so it was voted at the Oct. 11 meeting to authorize Chairman S. A. Browning to buy a new one for $50 on the installment plan.

MICHIGAN BRANCH Chairman Ray S. Jones opened the first meeting of the year on Oct. 18 with a welcome to the 55 old members and 25 prospective ones. Following this, Earle Kropscott, Dow Chemical Co., talked on "The Manufacture, Uses, and Properties of Plastics."

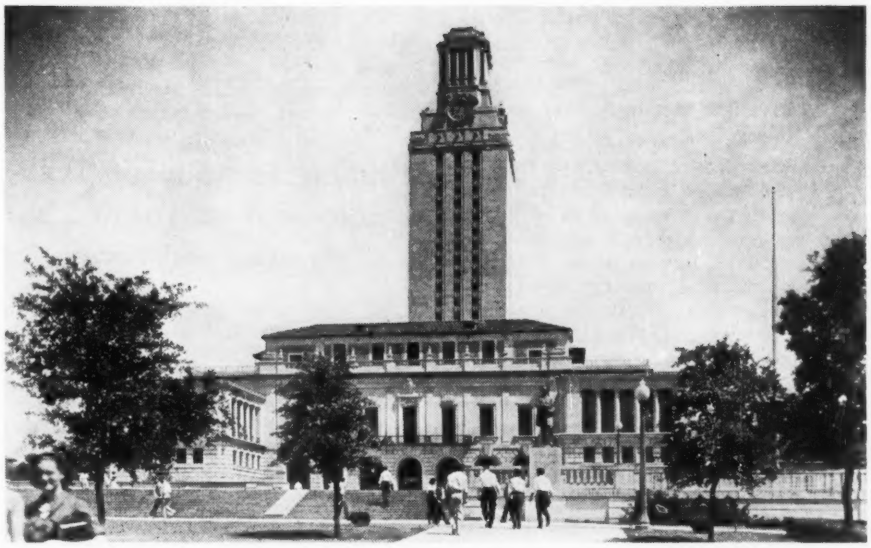
Michigan State Halloween Party

The first meeting of MICHIGAN STATE BRANCH on Oct. 26 was a combination meeting and Halloween party. Meeting in the power lab, which was decorated with black and orange streamers and jack-o'-lanterns, 130 members and guests were served the following by four members dressed up as waitresses: Cider—S.A.E. 10W, sugared toroids (doughnuts to you), adiabatically expanded corn (popcorn), and case-hardened apples. Chief engineer of the evening was F. D. Elwell, chief engineer of the Buick Motor Co., who enumerated the characteristics in a young engineer which help him to success.

MICHIGAN MINES BRANCH reports the promotion of Thomas E. Richards, G. R. Elwell, and Jacob Jacobson of the mechanical-engineering staff, and the addition of Edwin Swifka to that staff, which brings the number of faculty members in the school to 79. The student body, including mechanical engineers, numbers 874.

Minnesota Has Membership of 120

Climaxing a ten-day membership drive with a meeting on Oct. 26, MINNESOTA BRANCH reports a total membership up to that time of 120—59 seniors, 42 juniors, 16 sophomores, one freshman, and two graduate students. The program of the meeting consisted of a fencing demonstration by members of the athletic department and the showing of a motion picture on "Wire," obtained from the Bethlehem Steel Corp.



UNIVERSITY OF TEXAS MAIN BUILDING WHICH WAS INSPECTED BY TEXAS BRANCH MEMBERS

MISSOURI MINES BRANCH devoted its meeting of Oct. 24 to a discussion of the experiences of members during the summer. Ray Vaughan spoke on "Production Machinery and Factory Layout" of the Curtiss-Wright airplane plant in St. Louis, and Henry Walpers described the construction of the Wappapello flood-control dam in the southeastern part of Missouri.

MONTANA STATE BRANCH members heard a talk on Oct. 19 by Mr. Harrington, supervising architect for the new student union building.

NEW HAMPSHIRE BRANCH finally solved the perplexing problem of selecting student speakers for meetings by adopting at the Oct. 6 meeting a plan whereby the name cards of members were shuffled and the speakers for the term chosen according to the order in which their names appeared.

L. K. Sillcox at N.Y.U.

Through the efforts of the N.Y.U. BRANCH (evening), L. K. Sillcox, member A.S.M.E., presented the address at the evening division's class-day exercises on Oct. 28. Entitled "Thinking Ahead," his talk may be summarized by one of his sentences, "Success must depend, not only upon the individual's special fitness for his work, but also upon the zeal with which he undertakes it and the qualities of character which he displays."

NORTH DAKOTA BRANCH met on Oct. 18 and had a program featuring talks by Karre Loftheim and Bob Whempner.

NORTHEASTERN BRANCH reports that Dr. Frank Palmer Speare, founder and president of the school for 42 years, has announced his retirement, effective June 30, 1940. His successor is Dr. Carl Stephens Ell, member A.S.M.E.

OHIO STATE BRANCH held a joint meeting with the S.A.E. chapter on Oct. 6, at which time A. G. Christie, President of the A.S.M.E., was the guest speaker.

OKLAHOMA BRANCH opened its meeting of Oct. 5 by passing out cigarettes to those present. After talks by Professors Sims and Ambrosius, and an announcement by Chairman W. F. Ford that the membership on that date was 76, the meeting was adjourned.

PENNSYLVANIA BRANCH members at the meeting of Oct. 18 elected S. E. Griffin to fill the vacant seat of chairman. C. T. Horner was chosen to fill Griffin's former position of vice-chairman.

PRATT BRANCH held a meeting on Oct. 12 at which J. B. Fullman, A. M. Byers Co., described the making of wrought iron. This was followed by motion pictures showing the manufacture of various products from wrought iron.

PRINCETON BRANCH'S Oct. 19 meeting was opened by Chairman Richard Lovelace, who introduced the following student speakers: Wylie, Newbold, and Luzzatto, who spoke on summer job experiences.

Purdue Welcomes President Christie

President A. G. Christie was the guest speaker at the Oct. 5 meeting of PURDUE BRANCH. Before 200 members and guests, he presented a paper on "Creative Engineering."

ROSE TECH BRANCH called a special meeting on Oct. 23 to welcome Ernest Hartford, assistant secretary of the A.S.M.E., who gave a short talk on the advantages of membership in the Society.

U.S.C. BRANCH had two interesting meetings during October. On Oct. 11, Mr. Widener, of SKF Industries in Los Angeles, described the manufacture of roller and ball bearings. At the Oct. 25 meeting, Mr. Leossing, of Columbia Steel Corp., presented a sound motion picture on the construction of the San Francisco-Oakland Bay Bridge.

TENNESSEE BRANCH met on Oct. 27. Bill Tunnill and Walter Gill were elected A.S.M.E. representatives on the engineers' committee. After the appointment of various committees

by Chairman Jack T. Edwards, Professor Morton presented a short motion picture on internal-combustion engines.

Excellent Meetings at Texas

TEXAS BRANCH had several excellent meetings during the month of October. On the ninth, a two-reel motion picture on the mining, transportation, and manufacture of iron and steel was shown; 11th, talk on quick freezing by Luis Bartlet, member of the University's research staff; 23rd, inspection of all campus utilities; and 30th, presentation of papers by student members. Credit for the arrangements goes to William Lubbock, chairman of the Program Committee.

TEXAS A.&M. BRANCH had 140 at one meeting and 114 at another meeting. These large audiences may be attributed to the fact that before the start of the regular part of the program, cigars are given to all present and Mickey Mouse movies are shown.

TUFTS BRANCH had Paul Field, materials engineer of the Bethlehem Shipbuilding Corp., as the guest speaker on Oct. 18. He discussed the problems encountered by engineers in dealing with personnel.

Vanderbilt Has Record Enrollment

With a membership at present of 25, VANDERBILT BRANCH has the largest enrollment in its history, according to a report by Secretary C. Darby Fulton. At the Nov. 1 meeting, plans were made to take a trip to Birmingham, Ala., in the spring. After a discussion concerning operation of the Branch's candy store, which has furnished considerable revenue in the past, the meeting was adjourned.

VERMONT BRANCH devoted its Oct. 20 meeting to a discussion of "Undergraduate Research." Prof. H. Daasch listed the following as possible subjects for research by student members: Gasolines, fans, stress analysis, refrigeration, metal cutting, time study, fatigue of metals, and welding.

VILLANOVA BRANCH members at the Oct. 24 meeting discussed plans for the next meeting, which is to be an inspection trip to Chester, Pa., and a smoker.

Rankine Memorial Movement Started by V.P.I. Branch

V.P.I. BRANCH, the faculty of the school, and the V.P.I. Alumni Association have started a movement among the 150 engineering colleges in the United States to establish some kind of memorial for Prof. William John MacQuorn Rankine, whose splendid contributions to engineering have never been adequately recognized nor his memory suitably commemorated in this country. Further information about the movement may be obtained from Prof. William H. Rasche of V.P.I.

WASHINGTON BRANCH met on Oct. 19. After a discussion of membership, banquet, intramural football, open house, and other campus projects, Bob Foster introduced the speaker, H. Smith, connected with the Hartford Boiler Insurance Co., who described the changes which have been made in boilers during the last decade.

WISCONSIN BRANCH members on Oct. 12 heard a talk on the part of mechanical engineers in the development of the automobile, which was given by Walter A. Olen, president of the Four-Wheel-Drive Auto Co. His forceful and thoughtful presentation of the subject caused much favorable comment and opened up some entirely new channels of thought.

Illinois Institute of Technology to Be Formed by Armour and Lewis

AN announcement was made recently by James D. Cunningham, member A.S.M.E., and chairman of the board of trustees of Armour Institute of Technology, and Alex D. Bailey, past vice-president A.S.M.E., and chairman of the board of Lewis Institute, that their respective institutions had entered into an agreement to consolidate into a great new technological center for Chicago. This is the first occasion on which two colleges of engineering have ever agreed to merge their interests to produce an institution of more important scope, according to the statement of Mr. Cunningham and Mr. Bailey.

The name of the new school is to be Illinois Institute of Technology. The actual consolidation of the educational program will be complete by September, 1940, and the balance of this year will be given over to planning an integration of activities. For the time being it will be necessary to operate both the Armour and Lewis plants, but the complete development of the new center of technology contemplates the acquisition of a new, well-planned campus, conveniently located, to meet the needs of its broad objectives.

Proceedings of Oil and Gas Power 1939 Meeting Now Available

A LIMITED number of copies of the Proceedings of the meeting held at Ann Arbor, Michigan, June 19–22, 1939, are available for the price of $1.25. These Proceedings include fourteen papers together with discussion, figures, and illustrations and are arranged in a convenient spiral binding.

When requesting copies of the Proceedings a check should be sent to eliminate billing. Since the number of copies is extremely limited, because they are distributed gratis to the members registered in the Oil and Gas Power Division, orders will be filled according to the order in which they are received. Requests should be addressed to Ernest Hartford, assistant secretary, A.S.M.E. Professional Divisions.

Photoelasticity Conference Cambridge, Mass., Dec. 9

THE tenth semiannual meeting of the Eastern Photoelasticity Conference will be held on Dec. 9, at Cambridge, Mass., under the auspices of the department of mechanical engineering at M.I.T. All inquiries should be addressed to W. M. Murray, Room 1-321, M.I.T., Cambridge, Mass.

A.S.M.E Petroleum Division Appoints W. J. Overton as Secretary


WM. J. OVERTON

EFFECTIVE Oct. 16, William J. Overton, of Tulsa, Okla., became secretary of the Engineers' Club of Tulsa and the Petroleum Division of the A.S.M.E. He takes over the duties relinquished recently by J. H. Engelbrecht. An electrical - engineering graduate of Kansas State College, Mr. Overton has been a resident of Tulsa for the last 25 years. He will cooperate with Dean W. H. Carson, of the engineering college at the University of Oklahoma, as a representative of the Division which is sponsoring the fluid-meters research at the University. Mr. Overton will be available both to resident and to visiting A.S.M.E. members in Room 211, Midco Building, Tulsa.

Assistance for Subscribers of European Scientific Journals

THE nonreceipt by a subscriber of any European chemical or other scientific journal seriously needed as research material should be promptly reported to the American Documentation Institute.

The Cultural Relations Committee of ADI, which cooperates closely with the Cultural Relations Division of the Department of State, is working on this problem, and hopes to be able to surmount such war obstacles as interrupted transportation, embargoes, and censorship, which so greviously affected the progress of research during the last war. The principle should be established, if possible, that the materials of research having no relation to war shall continue to pass freely, regardless of the countries of origin or destination.

Reports, with full details of where subscription was placed and name and address of subscriber, volume, date, and number of last issue received, should be addressed to American Documentation Institute, Bibliofilm Service, care of U. S. Department of Agriculture Library, Washington, D. C.

Petroleum Fluid Metering Conference Is Postponed

ORIGINALLY scheduled to be held in Norman, Okla., Nov. 2–4, 1939, the Petroleum Fluid Metering Conference has been postponed until April, 1940, due to circumstances which are entirely beyond the control of the A.S.M.E. Petroleum Division.

1940 John Fritz Medal Awarded Posthumously to C. F. Hirshfeld

POSTHUMOUS award of the 1940 John Fritz Gold Medal, one of the highest honors in engineering bestowed in the United States, to Clarence Floyd Hirshfeld, fellow A.S.M.E., who until his death on April 19 of this year was chief of research of The Detroit Edison Company, was anounced last month by the John Fritz Medal Board of Award, which is composed of 16 representatives of the four Founder Societies. The A.S.M.E. group consisted of Ralph E. Flanders, William L. Batt, James H. Herron, and Harvey N. Davis, all past-presidents of the Society.

The medal went to Dr. Hirshfeld "for notable leadership through research and development in power generation and electric traction, and for being a great teacher and friend of men both young and old." Modernization of the electric streetcar completely from trolley wire to track is among the host of engineering advancements credited to Dr. Hirshfeld. After teaching at Cornell University from 1903 to 1914, he organized for The Detroit Edison Company what is thought to be the first research department established and maintained by an electric power company, and became chief of research. He was the author of many books and articles on technical subjects, dealing principally with thermodynamics, steam power, and problems of the transit industry.

A member of the American Committee of the World Power Conference, and of the U. S. National Committee of the International Electrotechnical Commission, Dr. Hirshfeld also served on the board of national councilors of the Purdue Research Foundation. He was the first chairman of the Engineers' Council for Professional Development, and belonged to many scientific societies, including A.S.M.E., Econometric Society, A.I.E.E., A.S.T.M., A.I.M.E., A.A.A.S., Army Ordnance Association, American Concrete Institute, Michigan Engineering Society, Detroit Engineering Society, and Sigma Xi.

Proceedings of Management Congress Now Available at Reduced Cost

UNQUESTIONABLY the most important management literature that has appeared in many years is included in the Proceedings of the Seventh International Management Congress, held in Washington, D. C., last year.

The set consists of seven volumes on the following subjects: Administration, general management, distribution, production, agriculture, and home management. Originally selling at $7 a set, the Proceedings may now be obtained at $3.75. However, the quantity is limited and it is advisable to order them promptly. It will not be possible to break sets to sell single volumes. Orders may be sent to A.S.M.E. Publications-Sales, 29 West 39th Street, New York City.

American Engineering Council

Presents

The News From Washington and Elsewhere

Annual Assembly of A.E.C., Washington, D. C., Jan. 11–12

THE Twentieth Annual Assembly of the American Engineering Council, of which the A.S.M.E. is a member body, will be held in Washington, D. C., Jan. 11–12, 1940. At this meeting there will be presented, for the first time, a comprehensive nation-wide picture of the activities of member societies—local, state, and national—in the solution of problems affecting the public welfare.

Strategic Minerals Sought

As the result of recommendations by the Army and Navy Munitions Board, the Department of the Interior now has engineering parties at work in seven states investigating possible sources of supply for minerals needed for national defense and not at present produced in sufficient quantities within the United States. Particular stress is being laid upon potential supplies of antimony, chromium, manganese, tin, and tungsten. The investigations are being carried on in Montana, Wyoming, Oregon, Washington, South Dakota, New Mexico, and Nevada.

President Roosevelt has issued a general request to owners of stocks of these and other important strategic minerals not to sell them to foreign purchasers but to hold them for possible use within this country.

Power Exports Supervised

Provisions of law whereby utilities within the United States are prohibited from constructing or operating facilities for the export of electric power without express permission from the Federal Power Commission have been supplemented by an executive order directing the Commission, before granting such a permit, to consult with the Secretaries of State and of War, and to procure the final approval of the President.

Major Reports Issued

Engineers and others interested in the broader aspects of economic problems relating to national resources will find much of interest in two comprehensive studies recently published by the National Resources Committee or, as it is now termed, the National Resources Planning Board. These deal, respectively, with the basic structure of the American economy and with energy resources of the United States. Containing 396 and 435 pages, respectively, each of these volumes is obtainable from the Superintendent of Documents, Washington, D. C., at $1.

"The Structure of the American Economy (Part 1)" is termed by the Committee "the first major attempt to show the interrelation of the economic forces which determine the uses of our national resources." It is essentially a qualitative and quantitative study (in so far as statistics are available) of the structure of the American economy for the purpose of clarifying the complicated picture and stimulating the development of possible solutions to economic ills.

"Energy Resources and National Policy" is limited, as the title indicates, to a narrower field, but goes further in that it includes findings and recommendations for future government policy. The bulk of the volume is devoted to an economic analysis of this country's energy resources—coal, oil, gas, and water power—with a discussion of the evolution of public policies relating to conservation and regulation. The balance of the book is devoted to the consideration of public policy as it should be shaped in the future in respect to each of the major energy resources.

While the general findings of the Committee were transmitted to Congress several months ago, the full text of the report has not hitherto been available.

Committee Hears Criticism of Civil Service

Many suggestions for the improvement of the federal civil service were presented at a public hearing held November 1 and 2 in Washington by the President's Committee on Merit System Improvement, which is now preparing a report that is expected to recommend the inclusion of higher grades of professional employees within the classified civil service system, as well as other changes.

The committee, which is headed by Supreme Court Justice Stanley Reed, includes in its membership Gano Dunn and Gen. Robert E. Wood as representatives of the engineering professions and of business, respectively, as well as a number of high government officials. It was formed by President Roosevelt last February and has been studying the problem since that time. The submission of a final report is anticipated in the near future.

Of the many persons who presented testimony at the hearing only one, General Counsel D. W. Robinson, Jr., of the Federal Power Commission, opposed the further extension of the merit system. It was Mr. Robinson's contention that because of the peculiar requirements of his agency it could do a better job of selecting its legal staff than could the Civil Service Commission. All other witnesses supported the merit system in principle, but most of them submitted specific criticisms of the manner in which it is now functioning, and some recommended material modification of its procedure in recruiting employees for the more responsible positions. A representative of the Department of Agriculture, for example,

suggested that its scientists and other experts be selected by joint boards made up from the Civil Service Commission, the Department itself, and one or more outside experts in the specific field involved.

Complaints directed at the administration of the present system may be briefly summarized as follows: Its examinations and lists are too general; too much time is consumed in the preparation of examinations, grading, and the compilation of eligible lists; registers are frequently too old; classification of jobs looks more to the number of subordinates controlled than to the real responsibilities of the position; present promotion and transfer procedure is inadequate; more attention should be paid to the training of employees for promotion. (Those who attended AEC'S Annual Assembly last January will remember that at that time a representative of the Civil Service Commission recognized the validity of similar criticisms, but contended that their remedy was largely in the provision of more personnel and funds.)

Provisions of basic civil service law that came in for criticism included the state-quota system and the preference granted to war veterans in grading applicants.

Employment Rises Sharply

Official reports by the Society Security Board for the month of August, compiled from the returns of state unemployment compensation plans, reveal sharp increases in the number of placements made in private industry by public employment agencies. A new high of 254,000 such placements was attained, an increase of 34 per cent over August, 1938. The active file of job applicants has been reduced to 5,800,000, the lowest level since December, 1937, and there has been a drop of 28 per cent in applications for unemployment benefits because of layoffs.

Relax Rules on Export of Military Planes

Government regulations governing the sale by private manufacturers of military aircraft developed for the U. S. Army and Navy have been relaxed in several particulars. Hitherto, it has been a rigid requirement that no sales could be made for foreign export until at least six months after the United States had received the second plane of a production order. Under the new regulations, however, the two services are given authority, at their discretion, to permit deliveries abroad simultaneously with those to the United States Government. It is pointed our that it is still possible for this country to tie up important military developments for an indefinite period when conditions justify.

The new regulations also permit aircraft manufacturers, when granted specific permission, to disclose to prospective foreign purchasers general information regarding the characteristics and performance of new types of planes while these are still undergoing tests, and to permit foreign pilots to make flights. Such acts have hitherto been forbidden, but will now be occasionally permitted under strict safeguards to guard military secrets.

1940 Nominating Committee to Be in Session at Annual Meeting for Suggestions of Candidates for Elective Offices

ARRANGEMENTS are being made for members of the Society to present to the 1940 Nominating Committee, at the time of the 1939 Annual Meeting, their thoughts concerning nominations for elective officers for 1941. This will give a large part of the membership an opportunity to appear before the Committee. It will also help the Committee to gain a better understanding of the desires of the members of the Society and enable it to start earlier its study of possible candidates.

It is, therefore, requested that members of the Society express their wishes to the Committee which will be in session at the Annual Meeting at the Bellevue-Stratford Hotel, Philadelphia, Wednesday, December 6 at 4:00 p.m.

Amendments to Constitution Approved by Membership

THE two amendments to the Constitution of the A.S.M.E., proposed by the Council and submitted for approval to the membership, were passed by great majorities, according to a report filed with the Secretary on Nov. 14, 1939, by the tellers, who counted the letter ballots. The tellers were the following junior members of the Society: H. G. Oliver, Jr., A. E. Blirer, and S. Schoor.

Out of 3870 ballots cast, 104 proved defective leaving a remainder of 3766 valid ballots, which were cast as follows:

Proposed Amendment	*Votes for*	*Votes against*
Art. C 7. Election of Directors. Sec. 3. *Directors shall be elected by sealed letter ballot of the membership.*	3512	254
Art. C 9. Meetings of the Society. Sec. 1. *The Annual Meeting of the Society shall be held at such time and place as the Council shall appoint.*	3390	376

A.S.R.E. Annual Meeting

AN INTERESTING ceremony commemorating the 35th anniversary of the founding of The American Society of Refrigerating Engineers will be one of the outstanding features of the annual meeting of the organization which is to be held in Chicago, Jan. 17–19, 1940, with headquarters at the Blackstone Hotel. Technical sessions will be devoted to the latest practice in industrial refrigeration, domestic-commercial refrigeration, and meat refrigeration.

New President of Worcester

THE new president of Worcester Polytechnic Institute, Rear Admiral Wat Tyler Cluverius, U. S. Navy (retired), was installed with appropriate ceremonies on Oct. 27. Representing the A.S.M.E. at the colorful function was I. E. Moultrop, former member of Council, who was appointed Honorary Vice-President of the Society for the occasion.

Local Sections

Coming Meetings

Anthracite-Lehigh Valley. January 26. Lafayette College, Easton, Pa., at 8:00 p.m. Subject: "The Rights of an Inventor-Employee," by H. H. Snelling, consultant, Patent Attorneys, Snelling & Hendricks, Washington, D. C.

Baltimore. January 10, 1940. Engineers' Club of Baltimore at 8:15 p.m. Subject: "Fundamentals of Operation Analysis," by Thomas W. Mele, Fisher Body Co., Detroit, Mich.

Chicago. December 12. Classroom, Chicago Lighting Institute at 7:30 p.m. Subject: "Radio Highways of the Air," by Capt. Jack Knight of United Air Lines, Dean of Air Mail Pilots, and holder of the world's record for hours and distance flown. This meeting will be conducted under the auspices of the Transportation Division of the Section with W. E. Dunham acting as chairman.

December 14. Classroom of the Chicago Lighting Institute at 7:30 p.m. Meeting will be under the auspices of the Junior Group. Subject: "Engineering for the Consumer," by W. B. Floyd, assistant in charge of laboratories, Sears, Roebuck & Co., Chicago, Ill.

December 19. Meeting under the auspices of the Management Division. Joint Meeting with The Society for Advancement of Management. Subject: "Training Executives," by Dr. O. W. Eshbach, Dean, Northwestern University School, Evanston, Ill. (For further information on this meeting, place, and time, telephone Midwest Office, Franklin 4250.)

Cleveland. December 14. (Place to be announced.) Meeting at 6:30 p.m. Subject: "Recent Advances in Power Generation," by James W. Parker, vice-president, Detroit Edison Company, Detroit, Mich.

Columbus. December 15. Battelle Memorial Institute, Columbus, Ohio, at 8:00 p.m. Subject: "Mineral Resources of the World," by John D. Sullivan, supervisor, Battelle Memorial Institute, Columbus, Ohio.

Florida. December 28. Hollywood, Florida, at 9:00 a.m. (Program not complete at time of going to press.)

Plainfield. December 12. Elks Club, Elizabeth, N. J., at 8:00 p.m. Subject: "Waves, Words, and Wires," by J. Owen Perrine, assistant vice-president of the American Telephone

(*A.S.M.E. News continued on page 946*)

& Telegraph Company, New York, N. Y.

Rock River Valley. December 7. Hilton Hotel, Beloit, Wis., at 7:00 p.m. Subject: "The Metropolitan Aqueduct," by Dr. William M. White, manager and chief engineer, hydraulic department, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

San Francisco. December 1. P.G.&E. Co. Auditorium, 245 Market St. at 8:00 p.m. This will be a joint meeting with the other Founder Societies, under the sponsorship of San Francisco Engineering Council. The meeting will be preceded by dinner at the Engineers' Club, 206 Sansome St., San Francisco, Calif. Subject: "Modern Motor Fuels and Their International Significance," by Dr. Gustav Egloff, director of research, Universal Oil Products Co.

Schenectady. December 14. Meeting will be held at 8:00 p.m. (place not chosen). Subject: "Recent Developments in Helicopters," by W. Laurence LePage, president, Platt-LePage Aircraft Co. This lecture and the pictures are the same as those presented on December 9, 1938, at the A.S.M.E. Annual Convention.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 25, single, Stevens graduate, 5 years' experience in heating, ventilating, and air conditioning. Desires permanent position anywhere in United States. At present temporarily employed on building program. Me-386.

MECHANICAL ENGINEER, 5 years' supervising mechanical equipment and production in nonferrous cold-drawing wire, rod, and seamless-tube mill. Operations included pickling, grinding, annealing, diemaking, design, heat-treating, laboratory experience. Me-387.

FACTORY SUPERINTENDENT, master mechanic, age 50. Experienced manufacturing small interchangeable apparatus, metal stampings, and automatic machinery. Well versed in design and construction of tools, dies, automatic tools, and machinery. Me-389.

INDUSTRIAL ENGINEER, B.S. degree, Lehigh University, June, '39; age 23. Interested in production or sales; willing to accept small salary in exchange for experience. Location open. Me-392.

GRADUATE MECHANICAL ENGINEER, class '39, age 23, single. Twelve months' drafting experience, 11 months' shop experience; desires opportunity in field of training leading to an engineering position. Location preferred, East. Me-393.

SALES ENGINEER, 36, married. Specialized in design and sale of welded pressure vessels, etc. Broad engineering experience. Desires position as salesman in South. Me-394.

MECHANICAL ENGINEER, 32, married, M.E. degree. Two years' production and development work, oil burners, valves, specialties. Previous 4 years' special studies telephone plant. Present temporarily employed as valuation engineer, available immediately. Me-395.

MECHANICAL AND STRUCTURAL ENGINEER with over 20 years' experience in chemical, copper, and rayon plant design, construction, maintenance, and research in States and South America seeks responsible position. Me-396.

GRADUATE MECHANICAL ENGINEER, 39. Broad experience in maintenance, steam power and piping, general design specializing in piping, pressure vessels, heat exchangers, piping specialties, mild steel, and alloys. Now employed. Me-397.

MECHANICAL ENGINEERING GRADUATE, honor student, 1939 graduate, age 27. Has had considerable experience in constructing and testing carburetors of own design. Desires opportunity for advancement in research and testing. Me-398.

POWER PLANT BETTERMENT ENGINEER, 45, single, M.I.T. graduate. Twenty years' experience utility and industrial plants in consulting and supervisory capacity of operation testing, heat balance, estimating, design, analysis, and construction. N. Y. professional engineer's license. Me-399.

MECHANICAL ENGINEERING GRADUATE, 24 years' Diesel and gas-engine experience, largely as engineering executive, covering two- and four-cycle types; successful executive with thorough knowledge of Diesel design and operation. Me-400.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

MAINTENANCE AND PRODUCTION ENGINEER with at least 4 or 5 years' experience in maintenance and production field in large, modern, progressive plant. Company manufactures dimension lumber and completely machined but unfinished furniture; employs about 200 workers. Must have initiative. Location, South. Y-4842.

MECHANICAL OR CIVIL ENGINEER with experience in incinerator work. Must be able to make report on, recommend, and design complete incinerator project. Location, New York, N. Y. Y-4853.

CHIEF DRAFTSMAN, experienced, for an established manufacturing organization employing large force of draftsmen. Apply by letter giving experience and qualifications, and enclosing recent photograph. Location, New York State. Y-4860.

MECHANICAL ENGINEER with experience in general water-tube boiler design and arrangement of accessories for boilers up to 600 lb pressure and a generating capacity of 150,000 lb of steam per hour. Should also be familiar with A.S.M.E. code requirements, and have reasonable knowledge of shop practice in so far as boiler fabrication is concerned. Familiarity with structural-steel design as applied to boilers and auxiliaries, together with pressure-vessel design also required. Duties will be to make designs according to specifications, to coordinate boilers and settings and all auxiliary equipment involved so that draftsman can prepare detailed drawings from them. Apply by letter giving education, age, experience, salary expected, etc. Location, Pennsylvania. Y-4861.

MECHANICAL ENGINEER, 35–50, to design and sell power-plant machinery to large central stations. Must have good personality. Salary, $5000 year. Y-4866.

SALES ENGINEER, 25–45, graduate mechanical or electrical engineer to sell transmission equipment. Company manufactures transmission belts. Salary and commission. Location, New York, N. Y. Y-4868.

STEAM POWER PLANT DRAFTSMAN, not over 45, with experience in high-pressure boilers (400 lb). Location, New York State. Y-4880.

PROJECT ENGINEER, not over 45, for layout work. Must have chemical-plant experience. Location, New York State. Y-4881.

ASSISTANT MECHANICAL ENGINEER, graduate M.E. with thorough knowledge of all equipment in high-pressure power station. Must be able to calculate all heat balances and assist in layout and design. Location, New England. Y-4900.

MECHANICAL OR CIVIL ENGINEER, not over 40, with experience in building maintenance and also interior building construction. Experience in large public buildings desirable. Salary, $4000–$5000 a year. Location, New York, N. Y. Y-4910.

DESIGNER with experience in design of high-speed Diesel engines. Apply by letter giving full details of experience, etc. Location, East. Y-4912.

MECHANICAL ENGINEER with experience in construction and operation of power plants, both steam and electric. Will be required to replace 14 hand-fired boilers for two mechanically fired boilers of higher capacity. Location, New Jersey. Y-4920.

PRODUCTION MANAGER, not over 45, American citizen, to supervise the production of a

(*A.S.M.E. News continued on page 948*)

A.S.M.E. Calendar

of Coming Meetings

December 4–8, 1939
Annual Meeting
Philadelphia, Pa.

May 1–3, 1940
Spring Meeting
Worcester, Mass.

June 17–21, 1940
Semi-Annual Meeting
Milwaukee, Wis.

September 3–6, 1940
Fall Meeting
Spokane, Wash.

(*For coming meetings of other organizations see page 22 of the advertising section of this issue*)

machine shop doing high-precision work. Should be engineer either through thorough experience, or graduation from recognized technical school, and have served his time as a machinist. Must be well versed in use of machine tools and latest developments in machine-tool field, and acquainted with modern production methods. Will be required to supervise machine shop employing approximately 100 workers, and will be responsible for heat-treating and electroplating divisions. Location, New York, N. Y. Y-4926.

GENERAL FOREMAN OR SUPERINTENDENT for machine shop engaged in building special automatic production machines for variety of products; also assembling and filling machines of all kinds. Must be able to prove outstanding mechanical ability and must have good technical background. Location, New Jersey, Y-4937.

FACTORY MANAGER, 40–50, for plant manufacturing steel furnaces for coal, gas, and oil firing, furnace and winter air-conditioning units for residences, furnace cabinets, furnace pipe and fittings, humidifiers, and accessories. Production departments consist of steel shop for fabricating steel furnaces in gages from No. 4 to No. 16, cabinet shop, sheet-metal shop, machine shop, assembly shop, and gray-iron foundry. Will be given full responsibility for all phases of production and purchasing, including factory personnel matters, cost reduction, and the purchase of all factory materials at proper costs, scheduling purchased parts to arrive in accordance with production schedule, and have experience in all of these duties. Should be able to organize and supervise work of others. Knowledge of accounting desirable, but not essential. Location, East. Y-4948.

SALES REPRESENTATIVE to sell services of large firm of consulting engineers to industrialists, utility officials, etc., in southern New England. Apply by letter giving age, education, engineering and selling experience, references, salary desired. Salary plus commission; also traveling and living expenses. Y-4961.

GENERAL FOREMAN, 35–45, with practical machine-shop experience. Company deals in sheet-metal machinery, power presses, rolling-mill equipment, etc. Salary, about $4000 year. Location, New England. Y-4963.

MECHANICAL ENGINEER to act as assistant to operating manager of large company. Must be able with help of three draftsmen to carry out in detail engineering problems, and must be interested in and capable of handling operating problems, including design of working schedules, cost, and labor statistics. Should have initiative. Experience in construction would be desirable. Salary to start, $300 a month. Location, Middle West. Y-4969C.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after December 26, 1939, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

BELITZ, WALTER B., JR., Baltimore, Md. (Rt)
BOYER, EARLE G., Philadelphia, Pa.
BOYLAN, GLEN D., Des Moines, Iowa
CARTER, J. H., St. Louis, Mo. (Rt)
CORNWELL, WM. A., Council Grove, Kan.
COUZINS, NEWTON W., Berkeley, Calif.
CREIGHTON, GRAHAM A., New London, Conn. (Re)
DANA, M. M., Arlington, Va.
DIETER, FREDK. A., Springfield, Mass.
DONNELLY, GEO. E., New York, N. Y.
ERHARDT, WALTER L., Beverly, N. J.
FRANKEN, THOMAS L., Cincinnati, Ohio
FULLER, WM. R., New York, N. Y.
GILMAN, R. E., Brooklyn, N. Y.
GORE, JOHN C., New Brighton, Pa.
GRIBBEL, JOHN, 2ND, Huntingdon Valley, Pa.
GRUCA, WALTER, East Chicago, Ind.
GURVITCH, J. E., Springfield, Mass.
HANSEN, MERLIN, Waterloo, Iowa
HOLTANE, THEO. K., Aruba, N. W. I.
JONES, ERNEST, Toronto, Ont., Canada
KIEFER, PAUL W., New York, N. Y.
KIN, MICHAEL, Garfield, N. J.
LEVIN, BERNARD S., Philadelphia, Pa. (Re)
LIBBY, CHARLES J., Richmond Hill, L. I.
LYMAN, THEO. B., Berkeley, Calif.
MACCHESNEY, H. GORDON, Peru, S. A.
MACFARLANE, GEO. F., Great Kills, S. I.
MAHONEY, MARTIN J., San Francisco, Calif.
MITCHELL, A. R., New York, N. Y.
OGLE, EMERSON DES F., Philadelphia, Pa.
OPATOWSKI, I., Minneapolis, Minn.
PUGSLEY, WM. H., Michigan City, Ind.
RIEDE, PETER M., Buffalo, N. Y.
SALTZER, B. H., Gettysburg, Pa.
SEATON, LAURENCE F., Lincoln, Neb. (Rt)
SHEEHAN, D. J., Danville, Ill.
SPERRY, ARTHUR G., Hollis, L. I.
SLATTERY, ROBT. O., Webster Groves, Mo. (Rt & T)
STEIGERWALT, ROBT. W., Pittsburgh, Pa.
STURM, ROLLAND G., New Kensington, Pa.
WEILAND, EDW., Milwaukee, Wis.
WEISER, EARLE P., Portland, Oregon
WELLER, PERRY R., Philadelphia, Pa.

CHANGE OF GRADING

Transfers to Fellow

EKSERGIAN, R., Philadelphia, Pa.
TRAINER, J. E., Akron, Ohio

Transfers to Member

CATALANO, ANTHONY V., Richmond Hill, L. I.
DOYLE, W. L. H., Peoria, Ill.
FOLEY, GLENROY B., Ridlonville, Maine
HIRSCH, CHAS. E., Billings, Mont.
LEUTWILER, L. G., Greeneville, Tenn.
MULLIGAN, PAUL B., New York, N. Y.

Transfers from Student-member to Junior, 6

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

ANDERSON, HENRY CLAY, October 14, 1939
BARNES, WILLIAM O., September 8, 1939
BARTH, CARL G., October 28, 1939
CLARK, A. M., February 10, 1939
HUMPHREY, ARTHUR L., November 1, 1939
MCCLINTOCK, A. P., October 6, 1939
MELCHER, CHARLES W., June 29, 1939
SMITH, A. PARKER, October 8, 1939
SOUNITZA, WLADIMIR, October 10, 1939
SWEETSER, W. J., October 16, 1939
VIALL, W. A., October 24, 1939

A.S.M.E. Transactions for November, 1939

THE November, 1939, issue of the Transactions of the A.S.M.E. contains the following papers:

- Lignite—a Grate-Fired Fuel of the Future in the Southwest, by C. J. Eckhardt, Jr.
- By-Product Fuels in the Steel Industry, by E. G. Fox and W. B. Clemmitt
- The Characteristics of Atmospheric-Type Burners When Used With Natural Gas, by E. D. Howe and H. G. Johnson
- Burning Pulp-Mill Waste From Sulphite Mill, by Grover Keeth
- Bagasse Furnaces, by E. W. Kerr
- The Effect of Preparation on Ash Fusibility as Revealed by a Study of Selected Illinois Coals, by L. C. McCabe and O. W. Rees
- Burning Various Types of Oil-Refinery Fuels, by A. L. Wilson
- The Analogy Between Fluid Friction and Heat Transfer, by Th. von Kármán
- Mechanical Purification of Steam Within the Boiler Drum, by M. D. Baker
- Fundamental Relationships in the Design of Cooling Towers, by G. R. Nance
- Boiler-Plant Performance With Natural-Gas Firing, by F. G. Philo
- Power and Steam Plants for Oil-Refinery Service, by C. E. Steinbeck

MECHANICAL ENGINEERING, December, 1939, Vol. 61, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 W. 39th St., New York, N. Y. Price 60c a copy, $5.00 a year; to members and affiliates, 50c a copy, $4.00 a year. Postage to Canada, 75c additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations


SKF
MADE IN U.S.A.
A.S.M.E.
SKF is proud of the fact that The American Society of Mechanical Engineers has decided to hold its 1939 meeting in Philadelphia, the home of SKF Ball and Roller Bearings. It hopes that many members will have an opportunity to visit the SKF plant. SKF Industries, Inc., Front St. and Erie Ave., Philadelphia, Pa.
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An invitation BY SKF
SKF
ROLLER BEARINGS

PLATE PLANER DOUBLES OUTPUT

OUTPUT of this plate planer was practically doubled, simply by lubricating the lead-screw with Texaco Crater Compound No. 0.

GENERAL VIEW of Steel Tank & Pipe plant at Portland, Oregon. This plant is Texaco lubricated throughout.

Texaco Dealers invite you to tune in The Texaco Star Theatre — a full hour of all-star entertainment — Every Wednesday Night — Columbia Network — 9:00 E.S.T., 8:00 C.S.T., 7:00 M.S.T., 6:00 P.S.T.

EXPERIMENTING to find ways for increasing the output of its large plate planer, the Steel Tank & Pipe Co., Portland, Oregon, hit upon this happy solution.

By changing the lubrication of the lead-screw to Texaco Crater Compound they were enabled to take heavier cuts and increase the speed thus *practically doubling output.*

Texaco Crater Compound provides a viscous, tenacious lubricating film that doesn't squeeze out of place, but adheres to metal surfaces, protecting against friction and corrosion.

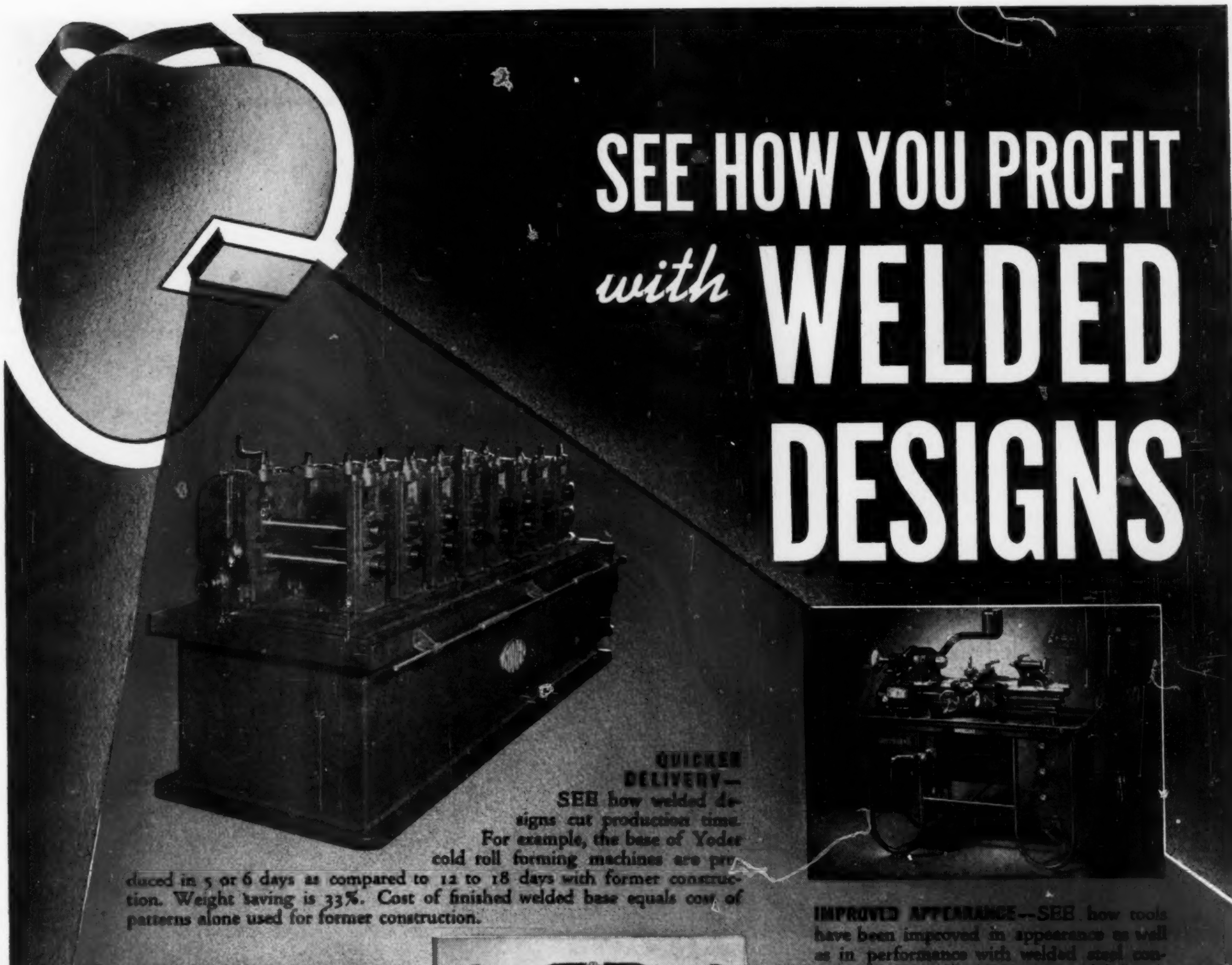
Experienced Lubrication Engineers, trained in the selection and application of Texaco Crater Compound, will be glad to demonstrate that savings can be made with Texaco Perfected Lubrication.

For prompt engineering service and deliveries, phone the nearest of our 2279 warehouses in the U. S., or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.

TEXACO
REG. T. M.

TEXACO CRATER COMPOUND


SEE HOW YOU PROFIT
with WELDED
DESIGNS
QUICKER DELIVERY—SEE how welded designs cut production time. For example, the base of Yoder cold roll forming machines are produced in 5 or 6 days as compared to 12 to 18 days with former construction. Weight saving is 33%. Cost of finished welded base equals cost of patterns alone used for former construction.
IMPROVED APPEARANCE—SEE how tools have been improved in appearance as well as in performance with welded steel construction. Example: This new model South Bend Lathe on welded steel bench.
REDUCED WEIGHT—SEE how welded steel has reduced the weight of tools and made them more rigid and practically unbreakable. This Wallace Bender weighs 736 lbs. as compared to 1250 lbs. for the former construction, cutting shipping costs and simplifying installation.
LOWER COST—SEE how welded designs such as this Doall Metalmaster give the buyer better machines at less cost. This all-welded machine sells for 33% less, weighs 25% less and has 2" greater throat capacity than the previous model.
GREATER PROFIT—SEE how you can cut costs and improve your products with welded steel construction!
Engineers in the nearest Lincoln office—experienced in all phases of welding production—are at your service. Call them or write—
IMPROVED PERFORMANCE—SEE how rigid, one-piece, all-welded frames of machines give superior performance. This frame of a Sturdybender bending press takes the heavy loads with minimum deflection, saving power and avoiding wear on ways and bearings.
THE LINCOLN ELECTRIC COMPANY
DEPT. T-641, CLEVELAND, OHIO • Largest Manufacturers of Arc Welding Equipment in the World

FAST HEATING BUT NO OVERSHOOTING IN MICROMAX CONTROL

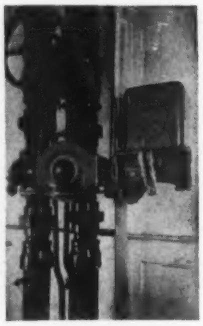
Taking charge once every five minutes of a fresh furnace-load of light metal stampings, the Micromax Electric Control equipment shown below relieves operators of all supervision of the heating and leaves them nothing to do but load the furnace cars and slide them into the furnace when the Micromax-actuated lamp comes on.

Changes in weight of load, changes in fuel pressure, and all other variables are automatically compensated for and cannot affect the heating.

Control is directed and temperature recorded by Micromax-equipped panel.

Parts being annealed are destined for subsequent stamping and deep-drawing operations, and the anneal is so uniform that rejects due to heat-treatment are almost unknown.

Any other fuel-fired furnace—batch, car-bottom, or continuous belt-fed—could use this identical Micromax Control, without removal or addition of a single part. And temperature would be held as closely as furnace design and construction permit. Any plant can standardize on Micromax Control, for the protection of product quality and reduction of manufacturing costs. Catalog N-OOB, "Micromax Electric Control", explains the Control, and our engineers are always ready to help you apply it.

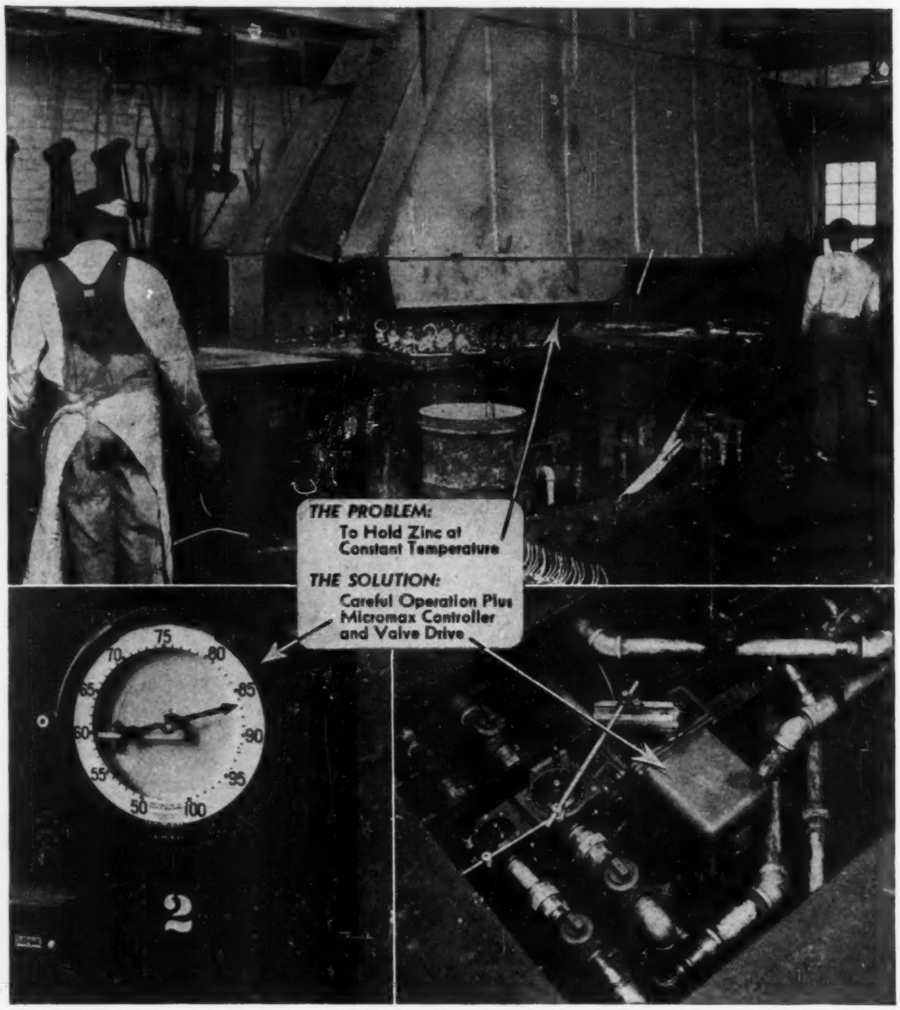


Fuel and air valve to furnace, and Micromax Electric Control valve-drive.

New Catalog of Lab Instruments

All L&N laboratory and test potentiometers, bridges and accessories, as well as all our other high-precision laboratory instruments, are briefly described and priced in our condensed Catalog E, just published for the first time. A copy will be sent on request.

Jrl Ad EN-0600A(1)



It's Easier to Put Zinc on Steel When Micromax Controls Its Temperature

Because correctness of temperature is now a "must" for first-rate galvanizing, a pipe-fittings plant recently put the temperature-control problem squarely up to Micromax. And Micromax is making the work easier, in at least 3 ways:

1. Workmen and foremen can read temperature, at any time and from any distance within the room. Even men who can't sign their names can tell temperature by the clock-like dial. Everyone is completely informed.

2. Control is extremely accurate because the micro-responsiveness of the Micromax instrument is carried through directly to gas and air valves. Never moving widely, these valves are nevertheless almost constantly in slight motion—just as though the foreman himself were operating them to head off temperature swings and keep them headed off.

3. Little service attention—ridiculously little—is required, and neither repair parts nor adjustments have been needed.

Any furnace, burning any fuel, can have these same advantages from an identical Micromax Controller. You can standardize on Micromax.

Write For Catalog N-33A, "Micromax Pyrometers"

LEEDS & NORTHRUP COMPANY, 4963 STENTON AVE., PHILA., PA.

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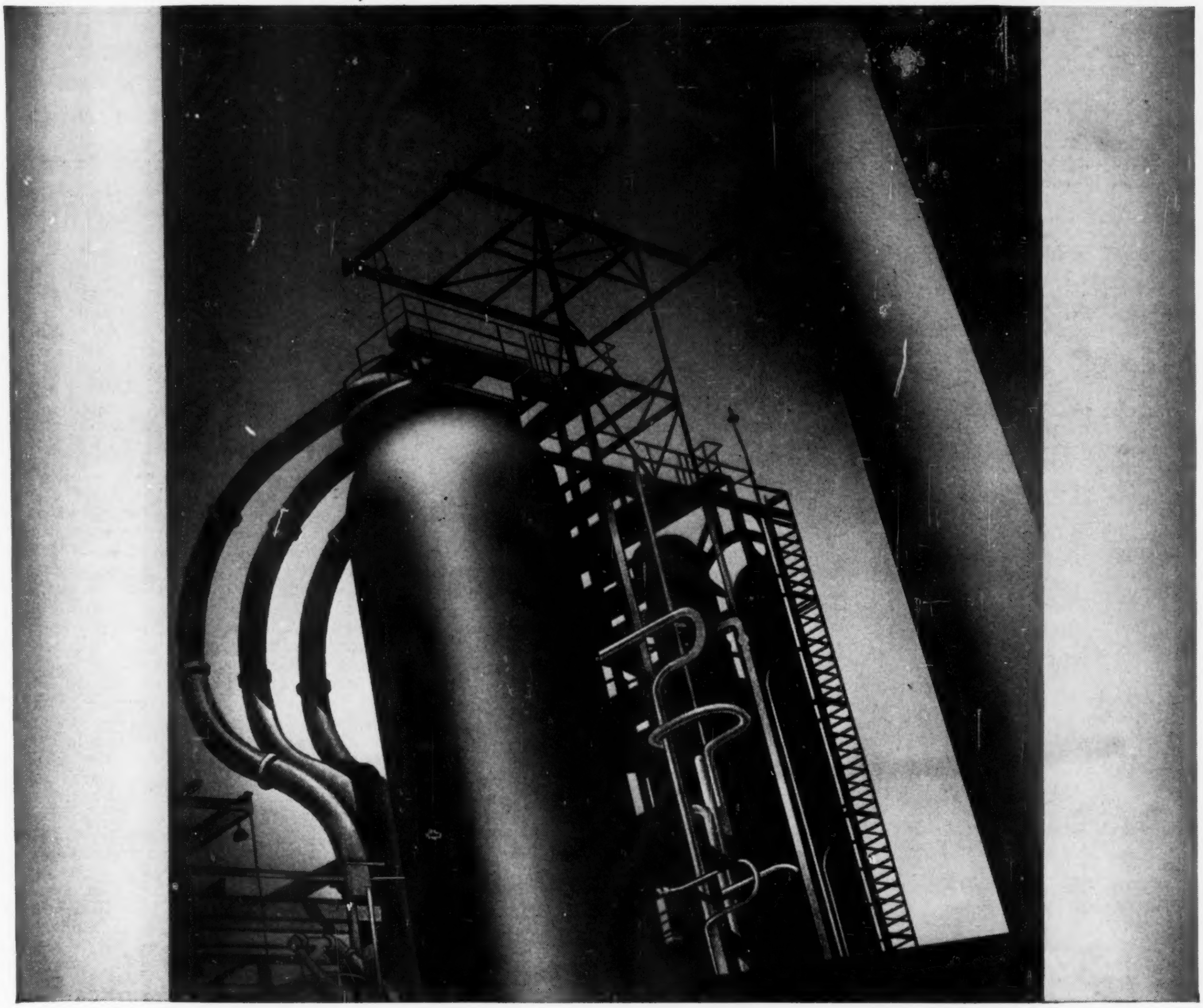
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES



BOTH LIGHT AND TIGHT

By no means least among the advantages of modern materials is the opportunity they afford the designer of matching more closely the service requirements of the job.

For example, Carbon-Molybdenum steel effectively meets the necessities of oil refining reaction chambers where temperatures are not over 1000 degrees F. and corrosion is not a factor.

First, its creep strength is so much superior to that of carbon steel that sections can be greatly reduced—resulting in a weight saving of approximately 40 per cent.

Second, it is readily weldable—so sound, pressure-tight joints can easily be made.

The net result is that Carbon-Molybdenum steel proves an ideal material for the construction of comparatively inexpensive, yet efficient and long lived vessels — when requirements are within the limits stated.

To assist you in checking your own material specifications we have prepared an authoritative technical booklet, "Molybdenum in Steel", which is sent free on request to interested production executives and engineers.

PRODUCERS OF MOLYBDENUM BRIQUETTES, FERRO-MOLYBDENUM, AND CALCIUM MOLYBDATE

MOLY

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•Keep Informed . . .

Announcements in this section are supplied by current advertisers in MECHANICAL ENGINEERING and A.S.M.E. MECHANICAL CATALOG. Space is restricted to these advertisers.

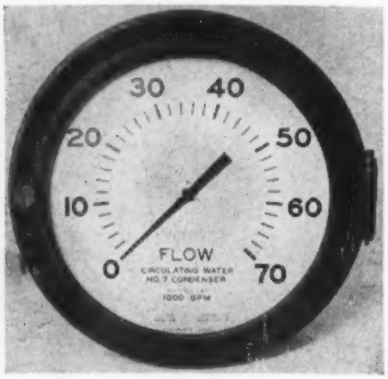
• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

Cochrane Meter Fits Board in Special Round Case

After laying out and fabricating the panelboard, a large central power station found that insufficient space had been provided for a standard electric flow meter to measure condenser cooling water. The only space available did not permit use of a meter having a case diameter greater than $14^1/_2$ inches.



Although the standard Cochrane Corp. electric flow meter is mounted in a rectangular 16 × $17^1/_2$-inch case, the design and construction of the internals readily lent themselves to installation in the smaller round case. The mechanism is the same as the standard meters described in publication 2096.

This particular electric flow meter measures flow of circulating water to a condenser in thousands of gallons per minute with a maximum range of 70,000 gallons per minute. Indicating, recording, and integrating flow meters—both mechanical and electrical types—are available for measuring flow of steam, liquids, and gases under a variety of conditions. Write Cochrane Corp., 3142 N. 17th St., Philadelphia, Pa.

New Hancock Valve

The Hancock Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a revolutionary type of steel valve called the Hancock "No-Bonnet - Joint" Valve.

This unique new valve has been developed to end leakage thru the gasket joint between the valve body and bonnet at elevated pressures and temperature. It does this because *there is no joint.* This feature is of particular interest to the oil, chemical and other industries handling explosive fluids where the hazard of leakage thru a bonnet gasket might be dangerous.

The Hancock "No-Bonnet-Joint" Valves are made for pressures up to 2500 pounds at 1000° F.

The makers state that this new valve weighs less than a fourth as much as a conventional bolted-bonnet valve of the same size and pressure rating.

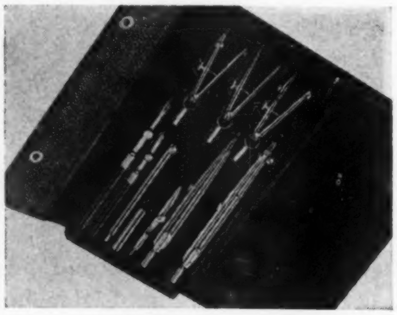
When a "No-Bonnet-Joint" is welded in the line, the only joint is that of the stuffing box for the stem. The valve may be easily disassembled in the line for regrinding.

The manufacturer claims that the annoyance of leakage thru the threads between the valve seat ring and the valve body can never occur in this new Hancock Valve. For it has no threads—its Stellite seat is welded onto the valve body and is an integral part of it. The valve disc is also heavily Stellited to resist wire-drawing and wear.

"No-Bonnet-Joint" Valves are made in one basic size and then tapped, or bored for welding, for $^1/_2$", $^3/_4$", and 1" pipe. This simplification cuts, by two-thirds, repair part and maintenance parts stocks and yet takes care of 90% of the small valve requirements on any high pressure industrial job, the builders state.

K & E Offers American Made Drawing Instruments

American made drawing instruments, developed for "straight line" production, are now in manufacture at the Hoboken, N. J. plant of Keuffel & Esser Co.



The new instruments are called "Minusa," a name made by contracting "Made in U. S. A."—They have a slender "rounded taper" construction, designed to produce excellent balance and a maximum of strength. Use of a special hard rolled nickel silver stock lends unusual rigidity to compasses, dividers and springbows. Careful hand fitting of all moving parts insures smooth, even action.

Except for the hand fitting operations, Minusa instruments are made by modern machine production methods throughout—a new technique that is said to represent a distinct engineering achievement. For over a century most of the drawing instruments used in America have been imported from Europe, where they are still virtually made by hand. Previous attempts to transplant the industry have followed European methods closely, producing excellent instruments, but at costs far higher than those of European manufacture, even after duties and freight have been considered. To develop modern machine methods that would actually improve on hand operations is said to have required detailed study by the manufacturer over a period of many years.

Although the first sets are already in the hands of key dealers and volume production is now under way, until manufacturing facilities can be extended, Minusa instruments will be offered in complete sets only. Single exception is the large ruling pen, available in unlimited quantities. The complete ten piece set bears a list price of $25.00.

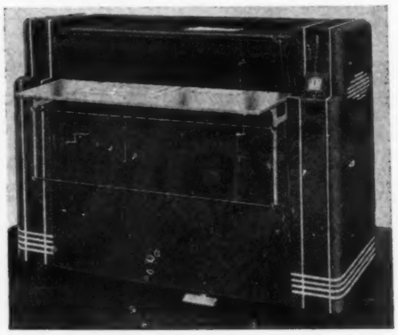
G-E Arc Welding Saves Manufacturer $2400 in Rebuilding Dies

A mid-west manufacturer was recently confronted with the necessity of either building two new dies to conform with an improved product design or revamp his existing dies. New dies would cost $2800 and would require eight weeks to build. To save this time and expense it was decided to have Atomoweld Co. rebuild the old dies, using a General Electric atomic hydrogen arc welder, previously purchased from Machinery & Welder Co. of Chicago. The dies were completely rebuilt in three weeks at a cost of only $400—a saving of $2400 for the manufacturer.

The cost of rebuilding the dies included annealing the dies for welding, the welding operation, machining and normalizing to remove strains, recarburization to harden the metal, and polishing. Using atomic hydrogen welding for this type of work, metal of the same carbon content and chemical analysis as the die material can be added, and the shielding action of the hydrogen atmosphere prevents the formation of impurities during the welding operation. The built-up area showed the same grain structure and hardness as the rest of the die.

New Mercury-Arc Light Blue Print Machines

A completely new type blue print machine, embodying as a major improvement the use of the Hanovia Chemical & Mfg. Co.'s new high pressure mercury quartz lamp, will be ready for announcement shortly after January 1st, according to officials of the Charles Bruning Co., Inc., 100 Reade Street, New York, N. Y.



In view of tests showing that this new light source overcomes the disadvantages inherent to carbon arcs, Bruning officials say that the new Hanovia lamp will replace carbon arcs in blue print machines. They point out that the new Hanovia high-pressure mercury quartz lamp should not be confused with the ordinary low pressure mercury tube used for

Continued on Page 18

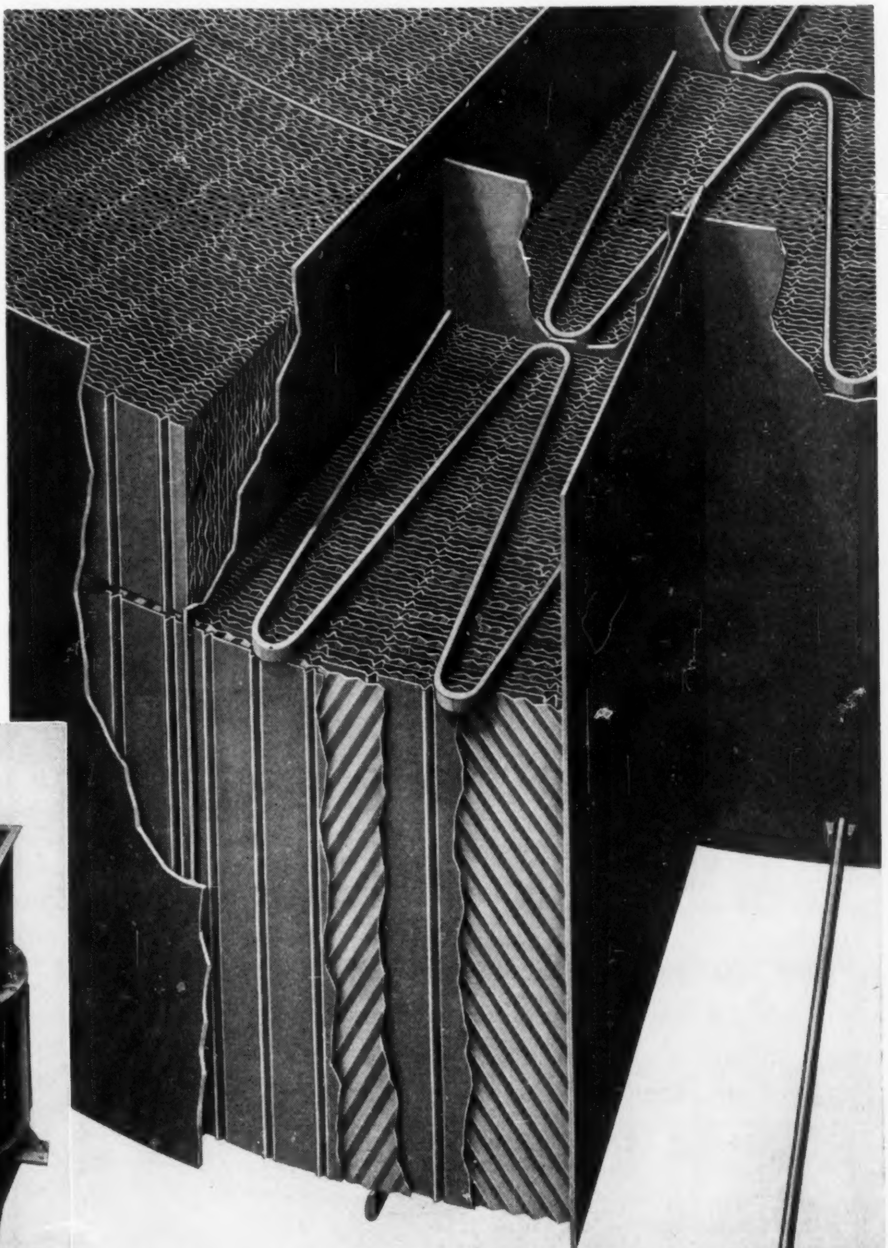
Ljungström *Air Preheaters Provide*

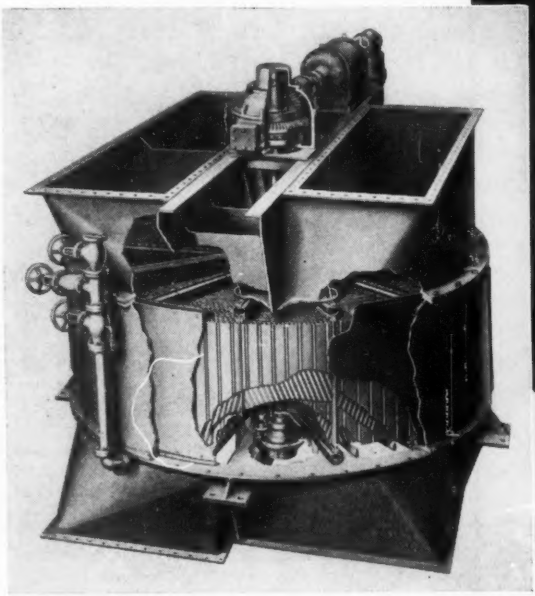
AVAILABILITY for ADJUSTMENT of HEATING SURFACES TO MEET CHANGING REQUIREMENTS

The large illustration shows the ease with which heating elements may be removed. This is a desirable feature in the event that heating surfaces should be adjusted to meet a change in operating conditions.

The number, the size and the type of surface of the elements may be varied to cover a wide range of operation.

Where operating conditions result in occasional low temperatures that cause corrosion, a double section of heating elements facilitates accessibility for inspection and replacements in the most economic manner.





THE AIR PREHEATER CORPORATION

Under the Management of THE SUPERHEATER CO.

60 East 42nd Street New York, N. Y.

A-1344

illumination and adapted to small, slow-speed blue printers. The Hanovia Chemical & Mfg. Co. guarantees a lamp life of at least 1,000 hours without any appreciable diminution of light volume during the life of the lamp.

Tests runs on a model of the new Bruning Mercury Blue Print Machine have been made at a speed of 20 feet per minute from new pencil and ink tracings using medium speed blue print paper—a speed not approached by most carbon arc machines.

This new quartz lamp gives positive, uniform distribution of light to the entire printing surface without flickering and eliminates the necessity of changing and trimming carbons. The current consumption of the new mercury printer is only $^1/_3$ that of a carbon arc machine of equal capacity.

In addition to the Hanovia lamp, the new Bruning machines will embody many mechanical innovations in safety, improved feeding speed control, drive, elimination of tracing slippage and wear, which will assure easier, faster and more economical operation and improved printing results. The first machine of this line will be available about January 1st and is designed to sell under $1000.00, Bruning officials state.

New Type Low-Current Arc Welder Announced

Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin, has come out with a novel design of low-current electronic arc welder for precision work. This so-called Weld-O-Tron unit can be used to weld with currents as low as 5 amperes, using newly developed $^1/_{32}$" and $^3/_{64}$" electrodes. Steels, stainless steels, and other metals lighter than approximately 18 gauge which hitherto could not be welded satisfactorily without seriously burning the

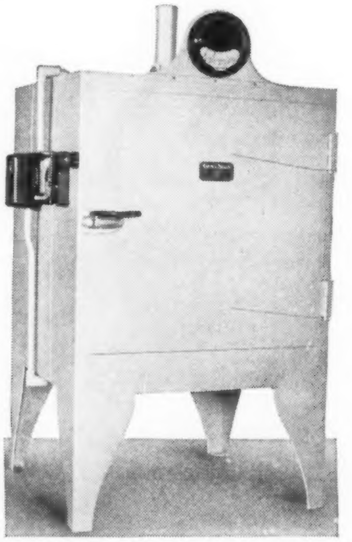
metal and destroying many of its vital properties, can now readily be welded. As a result, this new equipment is said to be applicable to many types of work previously considered too small or too light in construction for anything except riveting, spot welding, brazing or even soldering. It is stated that sheets as thin as 0.010", or approximately 32 gauge, can be handled without any difficulty.

The heart of the Allis-Chalmers portable Weld-O-Tron electronic arc welder is a multiple tube polyphase mercury vapor rectifier unit. It makes use of the newest type of rectifier tubes, specially developed for this equipment. The unit combines light weight, long life, and absence of rotating parts with the advantages of both a-c and d-c arc welding. The readily accessible controls and terminals are of the dead front type, and are located on the control panel. Two of them are simple two-way switches, one for current range selection, the other for reversing polarity of the tube terminals. A hand wheel, with easily readable dial, provides fine adjustment of the welding current. According to the Company, a constant current characteristic has been given to the Weld-O-Tron which makes the arc easy to start, easy to hold and which produces the optimum heat conditions at the weld. The same characteristics are obtained from minimum to maximum current settings.

The new Weld-O-Tron unit now being offered, and more completely described in Bulletin B-6049, was evolved to handle some of the Company's own intricate work for which there was no suitable machine on the market.

Laboratory or Experimental Oven

The Kirk & Blum Manufacturing Co. fabricators of all sheet metals, and designers, builders and installers of Industrial Ovens, Dust and Fume Control Systems, Pickling and Plating Equipment, etc., announce a small oven for laboratory and experimental work. This oven is specially made to meet individual requirements. It is for temperatures up to 700 degrees F.; is electrically heated and automatically controlled, being equipped with an automatic timing device.



Some of the reasons, according to the manufacturers, for the use of this oven are: it provides an economical means for experimenting with and testing materials and processes; it permits better control of and closer check on manufacturing processes; it assists greatly in the improvement of products.

Interesting details on this special K & B Laboratory or Experimental Oven, as well as full facts concerning complete K & B Engineering Service, will be mailed upon request by the Kirk & Blum Manufacturing Co., 2871 Spring Grove Ave., Cincinnati, Ohio.

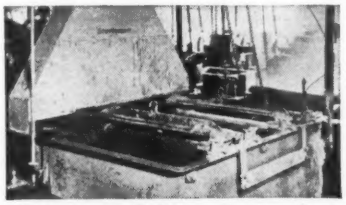
Air Conditioning Rents Office Building

New Orleans, La. (SPECIAL)—Occupancy of four office buildings in this city rose from 72.4 per cent to 87 per cent after air conditioning was installed, according to a

Continued on Page 20

JOE, YOU'RE NOT LOOKING SO GOOD LATELY

"No, Cora, I have been feeling rotten. I think it's those fumes at the plant."



Sturtevant Exhaust System for cyanide tank.

Sturtevant Grinder Exhaust System for carrying off emery and steel dust from grinding operations.

A HEALTH HAZARD such as this calls for *action.* Delay is likely to result in sad and costly consequences.

No matter whether your problem is one of removing fumes, dust, steam, or excess heat—Sturtevant can design a system for you which will effectively remedy the trouble.

Sturtevant Dust and Fume Removal Systems offer you many advantages. They assure you of a system exactly suited to your particular requirements—skilfully engineered—backed up by over 75 years of air engineering experience.

Write, briefly explaining your problem, and your inquiry will receive immediate attention.

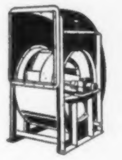
B. F. STURTEVANT COMPANY
Hyde Park, BOSTON, MASS. *Branches in 40 Cities*
B. F. Sturtevant Company of Canada, Ltd.
Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

FOR DUST AND FUME REMOVAL

Centrifugal Fans

A wide variety of types and sizes for exhausting or blowing service, including high pressure fans. Belt, motor, or turbine driven.

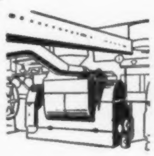


Air Washers

Made in several types and wide range of capacities to meet varying requirements in cleaning, cooling, dehumidifying, and humidifying air.

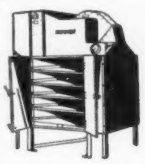
Air Conditioning

Individual units of equipment or complete central systems for maintenance of desired temperature and humidity in industrial air conditioning.



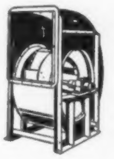
Drying Equipment

A wide variety of equipment for industrial drying in connection with textile, rubber, wood, leather, chemical, food, ceramic, and many other products.



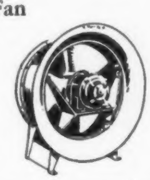
Corrosion Resisting Fans

Rubber-coated and special metal alloy fans for acid fume exhaust service. Belt, motor or turbine driven.



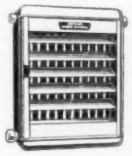
Axiflo Pressure Fan

Can overcome resistance of ducts, filters, prevailing winds, etc., up to 1½ in. water gauge, and possesses mechanical efficiency of over 79%. 11 sizes ranging from 18 to 60 in., with capacities up to 75,000 c.f.m. Furnished with either belt or motor drive. Wheel of acid-resisting cast aluminum.



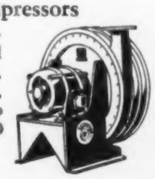
Suspended Speed Heaters

Propeller fan type, for wall or ceiling installation. Fin type heating element. For steam pressures up to 200 lbs., capacities up to 300,000 B.t.u.



Centrifugal Compressors

For industrial furnace, conveying and pneumatic tube work, gas boosting service, etc. Pressures: ½ to 5 lbs. Volumes: 50 to 50,000 cu. ft.



report issued recently by a group of realtors in cooperation with Carrier Corp., Syracuse, N. Y., air conditioning firm.

The air conditioning study was made by Carrier and the real estate men over a ten-year period in an effort to obtain reliable figures on tenant occupancy and tenant acceptance of air conditioning. The four buildings selected were the American, Whitney, Canal Bank and Hibernia.

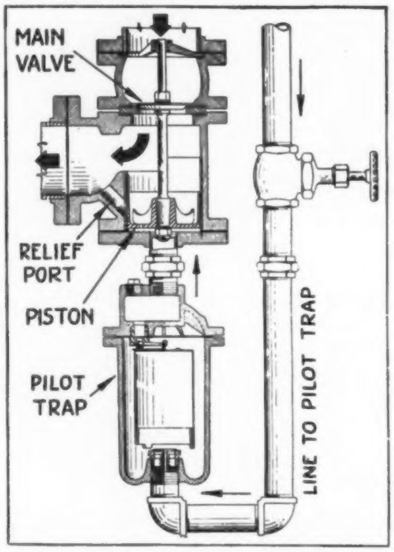
The study showed that these buildings reached in the period from 1933 to 1938 an average percentage of occupancy higher than the previous all-time high of 86.9 per cent in 1929 when business was booming. Just prior to the installations occupancy had dropped to a low average of 72.4 per cent.

The two buildings air conditioned over the longest period, the American and Whitney, have reached a percentage of occupancy of 99.9 per cent and 98.4 per cent respectively. These figures are of Jan. 1, 1939. The two buildings air conditioned most recently (1938) have both shown decided improvements in their occupancy percentage ratios.

During the period from 1929 through 1938, non-air conditioned buildings in New Orleans dropped from an average percentage of occupancy of 91.2 per cent to 67.2.

Giant Steam Trap Developed by Armstrong

A giant steam trap with 6 inch pipe connections and continuous flow capacity for 300,000 lbs. of water per hour at 50 lbs. pressure has just been announced by Armstrong Machine Works, 894 Maple Street, Three Rivers, Mich. Built first for draining evaporators in sugar refineries, it is now offered to engineers requiring automatic drainage for large steam purifiers, separators, flash tanks, heat exchangers, continuous blow down systems, multiple effect evaporators, etc.



As shown by the accompanying diagram the new unit consists of a large inverted bucket type pilot trap and a piston operated main valve. The main valve assembly is installed as an elbow on the drain line. The pilot trap is connected to the drain line at a point above the main valve assembly. In this manner, the main valve is kept sealed with water.

The operating cycle starts with flow of condensate to the pilot trap which discharges against the piston of the main valve forcing the piston upward until the relief port is uncovered. Because the piston head area is greater than the main valve cross-section area, it is possible to open the main valve against any pressure. Upward movement of the piston is checked by using the piston skirt to cut down the area of the main outlet port. Quick closing takes place when steam, instead of water, starts coming into the pilot trap and causes it to close. Use of the inverted bucket type pilot trap makes the unit non-airbinding.

Non-Breakable Transparent Plastic Gage Cover

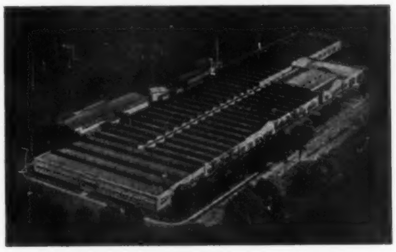
Ashcroft American Gauge Division, Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a new development which eliminates the breakage of glass fronts on indicating gauges. Instead of using the conventional glass and gauge ring, this new development is made out of a non-breakable, transparent plastic in the form of a cover which threads onto the gauge case. It is called the Transparent Gauge Cover. It is as clear as crystal. It is made out of trans-

parent plastic and has a tensile strength of about 5,000 lb. per square inch, and a compression strength of about 15,000 lb. per square inch.

The Transparent Gauge Cover opens up the dial of the gauge and makes it much easier to read. It also makes the case moisture-proof and dust-proof. It is the first attempt to stream-line a pressure gauge, and improves the appearance of a gauge considerably. The Transparent Gauge Cover is available on $4^1/_2$" and 6" Phenol Case Duragauges. Catalog on request.

• BUSINESS CHANGES

J & L Plant and Offices



The above illustration of the Jones & Lamson Machine Co., Springfield, Vermont, plant and office building shows the new extension recently completed. Continuous expansion of their business has increased the space required by their production lines and necessitated this extension, which extends from the facade for four bays back and covers an area of 24,000 sq. feet, and accommodates the entire Administrative, Clerical and Engineering force. The plant and office now covers $4^3/_4$ acres.

Patton Sale Manager of Alco Product Divisions

Effective October 18th, 1939, C. S. Patton was appointed Sales Manager of the Alco Products Division of the American Locomotive Co., 30 Church St., New York, N. Y., in charge of the sale of Heat Exchangers, Condensers, Feed Water Heaters, Evaporators, Tubular Equipment, Code Pressure Vessels, Fabricated Plate Work, Water Pipe and allied lines.

Continued on Page 22

Continued from page 20

Mr. Patton graduated from Cornell with the degree of Mechanical Engineer in 1918. For the following eight years he was connected with the ship building industry in various capacities with the Manitowoc Ship Building Co. of Wis., the U. S. Shipping Board, and the Staten Island Ship Building Co. In 1926 he accepted the position of New York Manager for the Biggs Boiler Works Co., of Akron, Ohio. In 1929 he took charge of the sales of fabricated plate work for the Heat Transfer Products Co., which position he held after the Heat Transfer Products Co. was acquired by the American Locomotive Co., and later expanded into Alco Products Inc. Later he was made Manager of Equipment Sales, Alco Products Division of American Locomotive Co., which position he has held up to his present appointment.

• LATEST CATALOGS

101 Welding Ideas

A new bulletin, "101 Welding Ideas for Low-Cost Maintenance," which illustrates and describes a wide variety of money-saving repair, fabrication and structural applications of arc welding, has just been published by The Lincoln Electric Co., world's largest manufacturers of arc welding equipment and electrodes, Cleveland, Ohio.

The new bulletin is published to show, by case studies of 101 actual maintenance jobs, just how general repair work of broken and worn parts—both structural and mechanical—also fabrication of replacements, piping, jigs, fixtures, etc., is done by the electric arc process. The great versatility of the process is indicated by its use in repairing parts of mild steel, high tensile steel, high manganese steel, stainless steel, chrome steel, light gauge steel, aluminum, cast iron, bronze, brass and copper, as well as applying new metal to worn parts to resist any type of wear action in service.

Included among the many case studies in "101 Welding Ideas for Low-Cost Maintenance," are repair jobs in pulp and paper mills, power plants, mines, construction projects, railroad shops, metal working plants, rock products plants, dredging operations, meat packing plants, truck and bus maintenance departments, gas plants, oil fields, steel plants, shipyards, pipe lines, garages and repair shops, rubber plants, etc. The wide variety of work is not only clearly illustrated by photos, but is described in considerable detail. Descriptions give procedure data, sizes of materials, as well as savings in weight, time and cost.

"101 Welding Ideas for Low-Cost Maintenance" will be found a valuable guide to savings in maintenance. From the great variety of jobs covered, maintenance officials will see applications in their own shops or plants where the arc welding method of repair can be used to great advantage. Study of their maintenance operations in the light of arc welding and the application of the process of such work has enabled users everywhere to save thousands of dollars annually.

Copies of the new bulletin may be obtained free upon request to The Lincoln Electric Co., Coit Road & Kirby Ave., Cleveland, Ohio.

"More Gallons at Less Cost"

The Centrifugal Pump Division of Allis-Chalmers Mfg. Co., Milwaukee, Wis., has issued a new Bulletin B-6108 called "How to Get More Gallons at Less Cost," which is an enlarged and revised edition on their SS Unit close-coupled pumps. It gives an interesting, well illustrated presentation of these small size, but versatile in application, pumps, including construction details, performance data, capacity tables, dimension sheets, friction tables and other valuable data.

"Dust Collecting Systems in Metal Industries"

This is the title of a 26-page book issued by the Kirk & Blum Manufacturing Co., 2871 Spring Grove Ave., Cincinnati, Ohio. It contains informative data on dust control and fume exhaust systems; and is profusely illustrated with photos of Kirk & Blum installations in plants of many of the foremost industrial leaders throughout the country. Every plant executive, interested in more efficient, more economical dust and fume control—thereby protecting workmen's health, improving working conditions and morale, increasing production, insuring a better product, reducing maintenance, and saving on insurance rates—should have a copy of this book in his files.

"45,000 Ways to Weigh"

Just how manifold are the modern requirements of scales in industry is set forth pictorially in a colored brochure now being issued by the Toledo Scale Co., entitled "45,000 Ways to Weigh."

The brochure, the third of its kind to be issued by the scale company, is the most widely used pictorial reference on scales.

It contains over a hundred illustrations, showing how scales are being used in the United States and abroad. The wide variety of sizes is presented also, with part of the pictorial layout demonstrating a few of the more obscure employments of Toledos, such as inspection of knee-action springs for autos, checking of Diesel engine performance, and inspection of fabrics.

Copies may be obtained by writing to the Advertising Department of the Toledo Scale Co., Toledo, Ohio, on firm letterhead.

Leather Belting Calculator

J. E. Rhoads & Sons, 35 North 6th St., Philadelphia, Pa., announces that they have available a new Leather Belting Calculator. It is based on A.L.B.A. Tables and prove of value to those who figure belting. One of these Calculators may be obtained by addressing Rhoads on your business letterhead.

Bristo Socket Screw Products

A new catalog just published by the Mill Supply Division of The Bristol Company, 21 Bridge St., Waterbury, Conn., gives the various reasons why Bristo Socket Set Screws and Cap Screws set faster . . . easier . . . and tighter.

The characteristic features of the Multiple Spline Socket are described, and information regarding raw material used and the heat-treatment of the finished product is also included. This new catalog contains prices and complete screw product specification data that will be useful to machine design engineers.

End Mounting Motors Described in New Leaflet

End mounting motors in both complete and skeleton types for air filters, blowers, hair dryers, sirens and other similar applications requiring this style of mounting, are discussed in a new leaflet of the Westinghouse Electric & Manufacturing Co.

An externally mounted thrust bearing is specially designed to permit adjustment, allowing end-play to be taken up after appliance is assembled. Skeleton motors can be furnished in other than end-type mountings when required.

Copies of leaflet F-8493 may be obtained from department 7-N-20, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

New "Phillie Gear" Catalog

Philadelphia Gear Works, Erie Ave. & G Street, Philadelphia, Pa., has just printed a 64-page catalog covering their line of Single, Double and Triple Reduction Herringbone Speed Reducing Units. These cover an extremely wide range of sizes and in the following ratios, Single from 1.75 to 1 to as high as 10 to 1, Double 10.55 to 1 up to 68.1 to 1, Triple from 60 to 1 up to 300 to 1. Dimensional drawings of reducers and of a complete line of base plates is shown. Couplings and a number of other Philadelphia Products are also illustrated and described in detail.

New Armstrong Steam Trap Book

Announcement is made by Armstrong Machine Works, 894 Maple St., Three Rivers, Michigan, of publication of a new catalog and educational handbook on condensate drainage. Out of a total of 36 pages, 18 are devoted to handbook material on rates of condensation, heat transfer, pipe sizes, piping layouts, maintenance, etc. Equipment covered by specific recommendations includes unit heaters, pipe coils, steam mains and steam purifiers. The catalog pages list all products in the Armstrong line and give complete information in sizes, capacities, prices, etc. High spots are forged steel traps for 2400 lbs. pressure and compound traps with capacity for 300,000 lbs. of water per hour.

COMING MEETINGS AND EXPOSITIONS

For the next three months

DECEMBER

4–8	American Society of Mechanical Engineers, 60th Annual Meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.
16th	Institute of Aeronautical Sciences, Inc., 3rd Annual Wright Brothers Lecture, New York, N. Y.
27–Jan 2.	American Association for the Advancement of Science, Winter Meeting, Columbus, Ohio.

JANUARY

10–12	National Aeronautic Association, Annual Convention, New Orleans, La.
15–19	S.A.E. Annual Meeting and Engineering Display, Book-Cadillac Hotel, Detroit, Michigan.
17–19	American Society of Refrigerating Engineers, 35th Annual Meeting, Blackstone Hotel, Chicago, Ill.
17–20	American Society of Civil Engineers, Annual Meeting, New York, N. Y.
22–26	American Institute of Electrical Engineers, Annual Winter Convention, New York, N. Y.
22–26	American Society of Heating & Ventilating Engineers, Annual Meeting, Hotel Statler, Cleveland, Ohio.
22–26	Sixth International Heating and Ventilating Exposition, Lakeside Hall, Cleveland, Ohio.
24–26	Institute of Aeronautical Sciences, Annual Meeting, New York, N. Y.

FEBRUARY

6–8	Steel Founders Society of America, Chicago, Ill.
Wk. of 12th	American Institute of Mining & Metallurgical Engineers, Annual Meeting, New York, N. Y.

For Calendar of Coming A.S.M.E. Meetings see page 946 in the editorial section

News of A·S·M·E Publications

· BOOKS · CODES · STANDARDS · SPECIAL REPORTS ·

Vivid Life Stories of Great American Engineers

To an engineer whose success lies in his relationship with, and understanding of people, the study of biography is one of the most profitable that can be undertaken.

The six books, briefly described on this page, are part of the A.S.M.E. Biographical Series. Each reveals a fascinating personality and covers every phase of the careers of men who knew and understood people. They are books that will be read for the stimulation that comes from intimate contact with successful lives and for the vivid and realistic accounts of human achievements. As Christmas gifts they are ideal.

Publication-Sales Department

The American Society of Mechanical Engineers
29 West 39th St. New York, N. Y.

LIFE OF HENRY LAURENCE GANTT
by L. P. Alford

This is a story of action. It is dramatic, for it shows the clash of stubborn wills. It is creative, for it deals with inventions and discoveries. It is intensely human, for it tells of both successes and failures. It is a distinct contribution to present-day economic and industrial thought, for it reveals Gantt's prophetic prediction of the current economic situation, and the solutions he advocated. **$5.00*** (20% Discount to A.S.M.E. Members)

BIOGRAPHY OF JAMES HARTNESS
by Joseph W. Roe

James Hartness lived and worked across the turn of the nineteenth century when the machine had become a dominant factor in modern life. His Biography which has been so ably prepared by Professor J. W. Roe, reveals a personality of diverse achievements, a pioneer in new methods of gaging, a leader in making high accuracy possible in mass production, a brilliant inventor, a successful business man, and a governor whose distinguished service to his State will be long remembered. Interwoven into his life story is an interesting account of the introduction of management mechanism. **$4.00*** (20% Discount to A.S.M.E. Members)

BIOGRAPHY OF JOHN STEVENS
by A. D. Turnbull

What is primarily the story of John Stevens is also the story of the early development of the American transportation system. It was Stevens who perceived the future possibilities of the steam motor and invented the multitubular boiler, forerunner of the small modern tube boiler. It was he who made the earliest American proposal to adapt steam to land use, and who built and drove the first steam carriage ever to run on rails in America.

The story of John Stevens well repays reading, for it is a narrative of intellectual power, inventive and experimental genius and perseverance. **$5.00*** (20% Discount to A.S.M.E. Members)

BIOGRAPHY OF ROBERT HENRY THURSTON
by W. F. Durand

The age into which Thurston was born was grappling with a new type of civilization in which the machine and mechanical power had introduced revolutionary forces, and the engineer was coming into prominence. Of this age, Thurston was a vital part. His life story, as portrayed by William F. Durand is a dramatic narrative of a far-visioned leader's career that cannot fail to inspire all who read it. **$5.00*** (20% Discount to A.S.M.E. Members)

BIOGRAPHY OF JOHN EDSON SWEET

John Edson Sweet to whom the A.S.M.E. owes its conception and organization came into the mechanical engineering field at a critical period of its growth. Through his designs and with the influence of his personality over the boys who sat at his feet at Cornell he disseminated his inherent enthusiasm for beauty of proportions in machines that had a far reaching effect on mechanical development. He foresaw the demands for accuracy in machine work with the consequent call for reference standards and he became one of the American pioneers in the production of such standards. The straight-line engine embodied his high ideals of design and construction. His biography is an interesting story of an unselfish teacher and a pioneering mind. **$4.50*** (20% Discount to A.S.M.E. Members)

AUTOBIOGRAPHY OF JOHN A. BRASHEAR

Brashear's life story will be a mine of encouragement to many readers, for in this record he has left inspiring proof that any perservering boy whatever his circumstances may overcome all obstacles and attain the highest success. This Autobiography reveals a life spent in unselfish pursuit of high ideals and tremendous tasks. **$5.00*** (20% Discount to A.S.M.E. Members)

{ * Combination price for six Biographies—**$25.00** (20% Discount to A.S.M.E. Members) }

The Standards COLUMN

News of Interest to Manufacturers

Acme Screw Threads

While it is generally recognized that the conditions surrounding the application of acme screw threads in industry often demand specialized treatment, the Sectional Committee on the Standardization of Screw Threads (B1), R. E. Flanders, Chairman, organized a subcommittee some time ago to collect data on present practice in the cutting of this type of screw threads and to attempt to set up standards for its important elements.

The chairman of this subcommittee is Earle Buckingham, Professor of Mechanical Engineering, Massachusetts Institute of Technology, and the following are the members of his subcommittee:

C. W. Bettcher, Vice-President and Sales Manager, Eastern Machine Screw Corp., New Haven, Conn.
Bureau of Engineering, Navy Department, Washington, D. C,
T. G. Crawford, Supervisor of Drafting, General Electric Co., Schenectady, N. Y.
A. M. Houser, Engineer of Standardization, Crane Co., Chicago, Ill.
C. M. Pond, Manager, Small Tool and Gage Division, Pratt and Whitney Co., Hartford, Conn.
H. W. Tenney, Mgr., Laboratories and Standards, Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.
O. B. Zimmerman, Consulting Engineer, Chicago, Ill.
R. E. Flanders (Ex-officio), President, Jones and Lamson Machine Co., Springfield, Vt.

This proposed American Standard covers the design and dimensions of the single acme and similar translating screw threads. The designs included have been chosen with the dual purpose of meeting the varied needs of the users to the greatest possible extent and at the same time establishing a product capable of economical production. The diameters and pitches have been carefully selected with a view to accomplishing this purpose with the fewest possible number of items thereby reducing to minimum the inventory of both tools and finished product. The tolerances are such as to produce complete interchangeability and yet maintain a high grade of product.

Four series of screw threads are specified in this proposed standard, the general purpose acme, the stubtooth acme, the 60 deg stub, and a modified square thread.

Copies of a tentative draft of this proposed American Standard are now available and will be sent to those especially interested, on application, with the understanding that the recipient will give the committee the benefit of his criticism and comment. Address the Chairman care of the A.S.M.E.

This project is being carried forward under the procedure of the American Standards Association with sixteen (16) organizations cooperating. The Society of Automotive Engineers and The American Society of Mechanical Engineers are the joint sponsor societies.

For further information—address

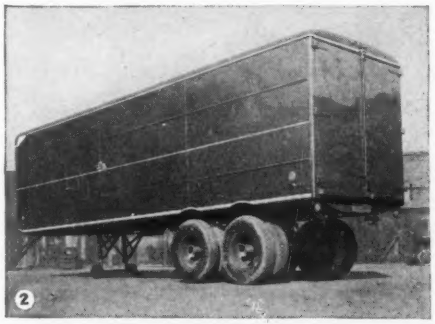
The American Society of Mechanical Engineers
29 West 39th St., New York, N. Y.

IT'S A DARE . . .

Weigh YOUR Equipment

. . . AND COMPARE IT *for lightness, strength and cost with U·S·S High Tensile Steel construction*

1



2

HERE'S a direct challenge to every user and builder of mobile equipment.

The safe reduction of deadweight with U·S·S High Tensile Steels—its resultant economies—its tangible returns in increased capacity and lower costs, are well-proved facts. You can't afford to overlook them.

Witness these typical applications:

1. In this 25 cu. yd. trailer dump truck, U·S·S MAN-TEN construction saves 3750 lbs. . . . reduces weight 25% below similar capacity trailer with structural steel body.

2. U·S·S COR-TEN in the bridge truss-type body frame reduces weight of this trailer 1800 lbs. . . . increases payload 1500 lbs. Unit is 33′ long, 8′ wide, 7′ high, weighs only 10,900 lbs. . . . estimated 4000 lbs. lighter than old equipment now on roads.

3. Mixing drum and mixing blades of this Trukmixer made of U·S·S MAN-TEN are 1/3 lighter—obtaining favorable payload—deadweight ratio vital in meeting highway load limit restrictions. Because of high abrasion resistance of MAN-TEN none of these drums or mixer blades has ever worn out in service.

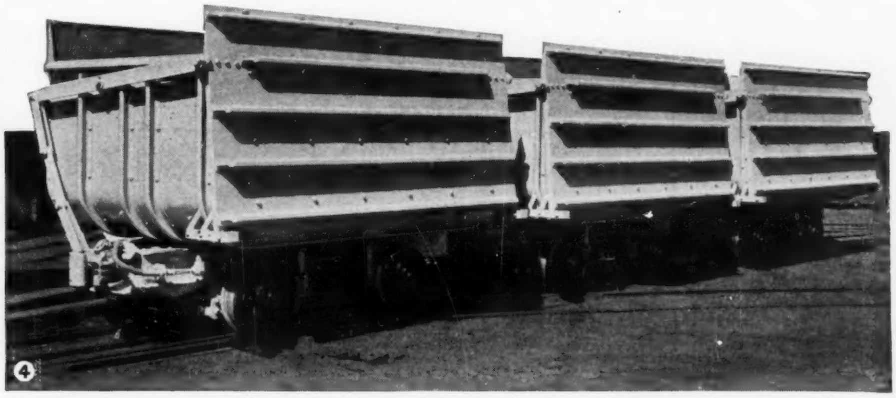
4. In 200 Granby-type mine cars, U·S·S MAN-TEN construction has reduced weight one ton per car; effectively reduces power consumption.

How does *your* equipment stack up? Is it still dragging around useless deadweight? Is it wearing out long before it should? Does it give you the capacity you have a right to expect? Rebuild it, *at low cost,* with service-tested U·S·S High Tensile Steels.

Both U·S·S COR-TEN and U·S·S MAN-TEN have yield points approximately 50% higher than structural quality open-hearth steel. Both are tough and hard wearing, highly resistant to shock and vibration—have ⅓ greater resistance to abrasion than mild steel. COR-TEN has unusually high resistance to atmospheric corrosion, 4 to 6 times that of plain steel. MAN-TEN equals copper steel in rust resistance.

But because both these superior steels are *low* alloy steels—their price is low. Thousands of applications have proved they will reduce weight with little or no increase in cost. May we tell you more about them?

3



4

USS

HIGH TENSILE STEELS

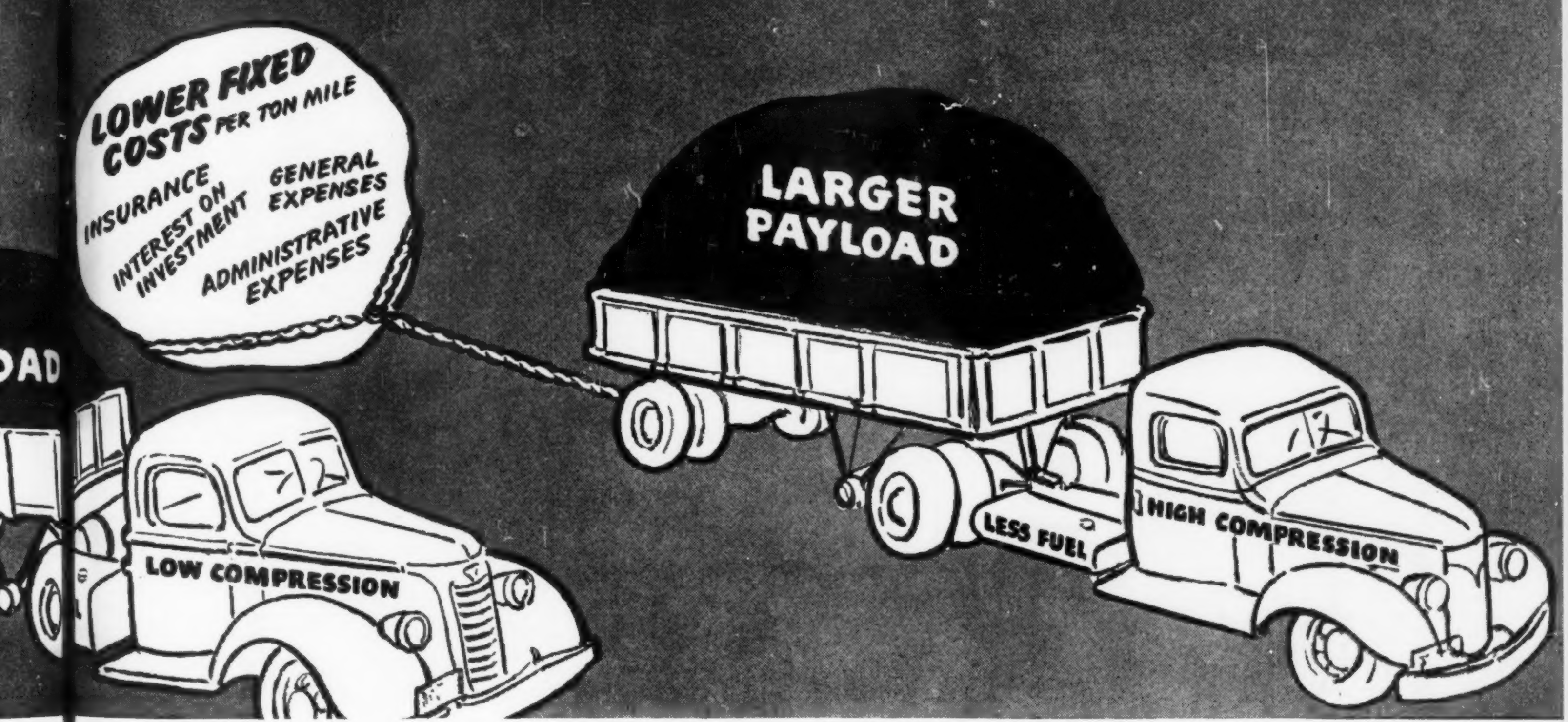
AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
NATIONAL TUBE COMPANY, *Pittsburgh*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*

Scully Steel Products Company, Chicago, *Warehouse Distributors* • United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

S PER TON OR PASSENGER MILE

ses ave high compression



Ton-miles per gallon of fuel are greater. Ton-miles per hour of driving time are greater. Charges per ton-mile to cover fixed costs are smaller.

Among the major costs of truck and bus operation are fuel, cost of drivers' wages and fixed costs, such as taxes, insurance, interest on investment and administrative and general expenses.

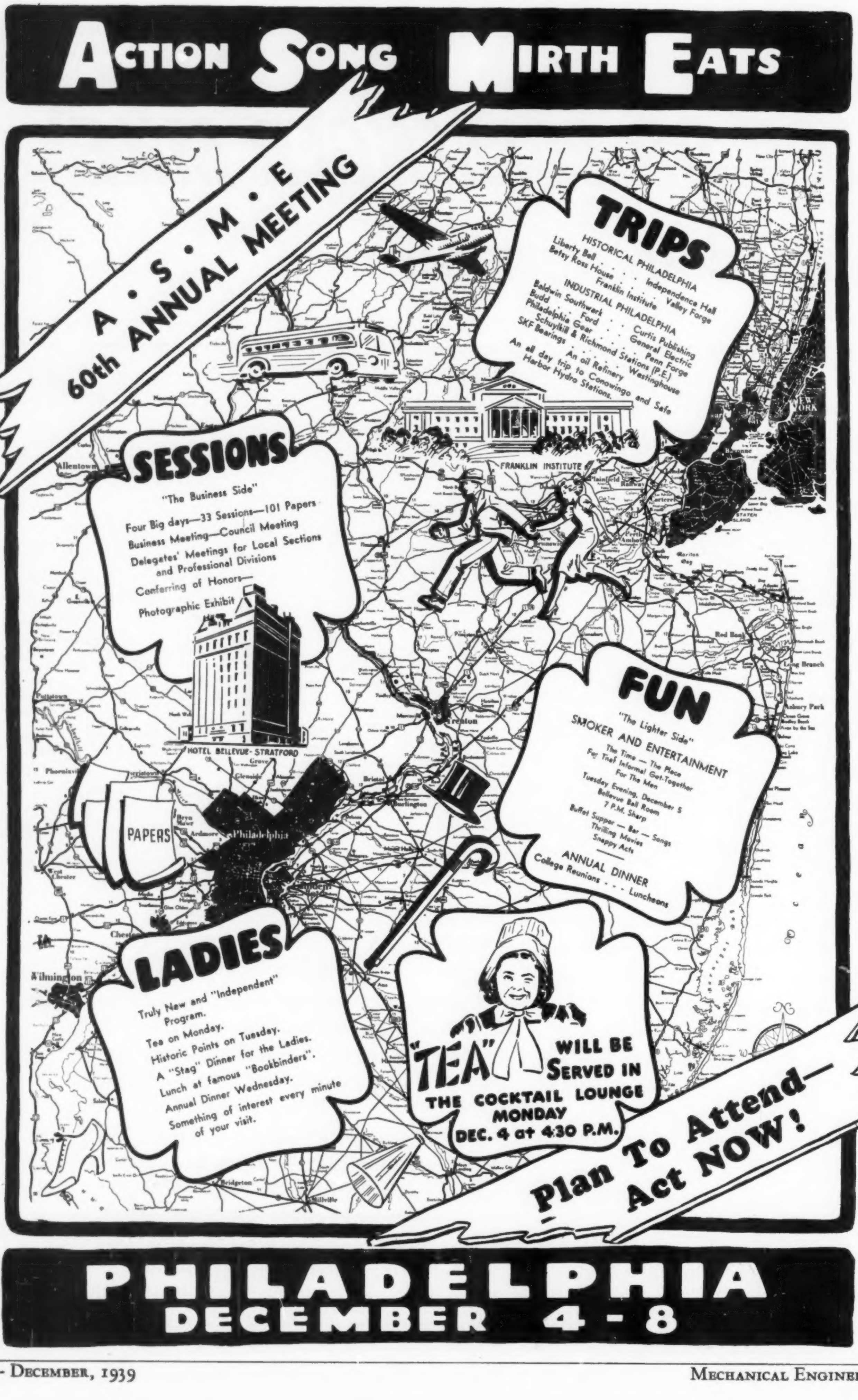
High compression reduces all of these charges applicable per ton-mile or passenger-mile. The results of a two-year series of comparative tests at San Bernardino, California, are shown in the charts on the opposite page. The same engine with a higher compression ratio reduced fuel consumption from 4% to 17% when either heavier payloads were hauled or faster speed per trip was maintained. The decrease in operating time of 7% to 8% represents a substantial saving in cost of driver's time for a given trip.

The increased payload and decreased time also mean more goods or passengers hauled per unit of time and therefore smaller charges against each ton-mile or passenger-mile for fixed costs.

The advantages of high compression, as demonstrated by the tests at San Bernardino, may be realized with today's fuels of higher anti-knock value by either of two procedures:

1. Selection of compression ratios for new vehicles as high as is practical for the fuel to be used.
2. Installation of high compression pistons or cylinder heads as replacements in low compression truck and bus engines now in service.

Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y.



ACTION SONG MIRTH EATS
A • S • M • E
60th ANNUAL MEETING
TRIPS
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Betsy Ross House . . . Franklin Institute . . . Valley Forge
INDUSTRIAL PHILADELPHIA
Baldwin Southwark
Budd . . . Ford . . . Curtis Publishing
Philadelphia Gear . . . General Electric
Schuylkill & Richmond Stations (P.E.) . . . Penn Forge
SKF Bearings . . . An oil Refinery . . . Westinghouse
An all day trip to Conowingo and Safe Harbor Hydro Stations.
FRANKLIN INSTITUTE
SESSIONS
"The Business Side"
Four Big days—33 Sessions—101 Papers
Business Meeting—Council Meeting
Delegates' Meetings for Local Sections and Professional Divisions
Conferring of Honors—
Photographic Exhibit
HOTEL BELLEVUE-STRATFORD
PAPERS
FUN
"The Lighter Side"
SMOKER AND ENTERTAINMENT
The Time — The Place
For That Informal Get-Together
For The Men
Tuesday Evening, December 5
Bellevue Ball Room
7 P.M. Sharp
Buffet Supper — Bar — Songs
Thrilling Movies
Snappy Acts
ANNUAL DINNER
College Reunions . . . Luncheons
LADIES
Truly New and "Independent" Program.
Tea on Monday.
Historic Points on Tuesday.
A "Stag" Dinner for the Ladies.
Lunch at famous "Bookbinders".
Annual Dinner Wednesday.
Something of interest every minute of your visit.
"TEA" WILL BE SERVED IN
THE COCKTAIL LOUNGE
MONDAY
DEC. 4 at 4:30 P.M.
Plan To Attend—
Act NOW!
PHILADELPHIA
DECEMBER 4 - 8

MECHANICAL ENGINEERING
November, 1939 CARD INDEX Vol. 61, No. 11

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Wanted—Equipment, Material
Patents, Books, Instruments,
etc. Wanted and For Sale

RATES

Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of 60 cents a line, 50 cents a line to members of A.S.M.E. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis, maximum 20 lines. Display matter carried in single column units of multiples of one inch a flat rate of $10. per inch per insertion. Copy must be in hand not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

GRADUATE ENGINEER with definite experience along the line of machinery testing and experimental work. In applying state education, experience, wage expectations and references. Address CA-426, care of "Mechanical Engineering."

YOUNG MAN experienced along METALLURGICAL LINES. Need not be a full-fledged metallurgist. Give full statement of experience, age, references, etc. Address CA-427, care of "Mechanical Engineering."

DESIGNING ENGINEER with ability to work along original lines in designing machine tools. Give full statement of experience, references, and other facts of interest to employer. Address CA-428, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Progressive manufacturer of road machinery and tractor equipment, middle west, requires an experienced, technically trained engineer. Must have plenty of ambition, initiative, design ability. Experience in the line preferred. Opportunity in executive capacity for right man. Address CA-429, care of "Mechanical Engineering."

MECHANICAL DESIGN ENGINEER—Experienced in high-pressure steam power plant work, piping, structural steel, and general mechanical design to direct draftsmen, inspect drawings for correct design and clearances to insure efficiency in erection, operation and maintenance. Location, midwest. State education, age, experience, and salary expected. Address CA-433, care o' "Mechanical Engineering."

POSITIONS WANTED

MECHANICAL ENGINEER, 26, single. Graduate, University of Vienna, University of Brussels. Industrial engineer in Europe and U. S. 3 years experience as draftsman. Now employed. Desires position as foreman or assistant to industrial or works engineer. Any location. Address CA-425, care of "Mechanical Engineering."

ORDNANCE, PRODUCTION ENGINEER experienced in the manufacture of six to sixteen high explosive shells, gun-mounts and in the design and construction of submarine torpedoes, precision ordnance mechanisms and associated apparatus, desires executive position requiring specialized knowledge of ordnance manufacturing. Address CA-430, care of "Mechanical Engineering."

PATENT ATTORNEY, experienced all phases patent work; N. Y. office, M. I. T. graduate, former Examiner; experienced mechanical and electrical art; expert—engines, hydraulic transmissions, power plants, mechanisms; seeks additional patent work or part-time connections. Address CA 434, care of "Mechanical Engineering."

MECHANICAL ENGINEER—with five years experience supervising mechanical equipment and production in a non-ferrous cold drawing wire, rod and seamless tube mill. Production operations included pickling, grinding, annealing, die making and design, heat treating and laboratory experience. Address CA-422, care of "Mechanical Engineering."

ENGINEER, Mechanical–Electrical, Professional license. Twenty years experience in design, layout, checking, supervision. Special machinery, electrical equipment, chemical plant layout, marine electrical installation. Light and heavy machinery. Experience in shop and field. Now employed. Capable taking charge of design, field supervision, etc. Address CA-419, care of "Mechanical Engineering."

MECHANICAL ENGINEER, BS—Purdue, age 27, married. Four years of extensive oil field experience, of which two years were in the design, testing and operation of oil field equipment. Now employed as production engineer. Will go anywhere. Address CA-418, care of "Mechanical Engineering."

WELDING ENGINEER—31; Graduate mechanical engineer with five years varied welding and flame cutting experience. Four years in machine shop. Familiar with compressors, pumps, boilers and can lay out work and instruct new men. Now employed as Master Mechanic on construction project nearing completion. Desire place as foreman or engineer in plant fabricating parts by flame cutting and welding, or responsible work in related field. Salary $50 a week minimum. Address CA-417, care of "Mechanical Engineering."

BUSINESS OPPORTUNITIES

MANUFACTURING RIGHTS to a fine modern line of machine tools. If you have facilities to handle assemblies from 4 to 10 tons, this line should interest you as it is one of the best known names in the machine tool world. It is available only because of deaths of the owners. Ray W. Summe & Co., 100 West Monroe St., Chicago, Ill.

WE ARE INTERESTED IN NEW PRODUCTS
Philadelphia Company of forty years' standing, making pressed steel and machined products for industry and selling them nationally through several hundred distributors, wants to expand its line by adding suitable new products. Can operate on royalty basis or buy outright Address CA-402, care of "Mechanical Engineering."

AMERICAN TRAINED ENGLISHMAN (member of A.S.M.E., A.I.E.E., I.S.E., R.I., and I.I.A.) with excellent references and connections in Europe meets, advises and represents American gentlemen with interests in Great Britain. Write in full confidence to Frederick Stanley Giller, "Fairseat," Hextable, Kent, England.

EQUIPMENT FOR SALE

EXCEPTIONAL OFFERING OF TWO SLIGHTLY USED 2500 KW ALLIS-CHAMBERS CONDENSING STEAM TURBO GENERATING UNITS in excellent condition for immediate delivery. Federal Engineering Co., Central Office Bldg., Davenport, Iowa.

PATTERNS, JIGS and FIXTURES for a thoroughly modern line of machine tools. Due to deaths of owners and manager, we are able to offer a line of fine tools which will give a heavy plant a fine additional volume. No indebtedness or plant is involved. Ray W. Summe & Co., 100 W. Monroe Street, Chicago, Illinois.

Use a

CLASSIFIED

ADVERTISEMENT

for

Quick Results

REPRESENTATION WANTED

PROMINENT MANUFACTURER of centrifugal pumps desires sales agents in Cleveland, Columbus, Louisville, Richmond, St. Louis, Peoria, St. Paul. We are not now represented in these cities. Our line includes sewage and drainage pumps to 20,000 G.P.M. Address CA-432, care of "Mechanical Engineering."

SALES ENGINEER—to represent established manufacturer of Speed Reducing Transmissions and Cut Gears on a commission basis in the States of California, Oregon, Washington, Idaho, and Utah. In reply state experience, age, interested territory and lines now handling. Address CA-404, care of "Mechanical Engineering."

SALES AGENTS in various parts of the United States to represent an established manufacturer of pressure regulating valves, steam traps, etc. Products of this manufacturer have given outstanding service and its regulating valves have important construction features that cannot fail to impress a prospective buyer. Address CA-406, care of "Mechanical Engineering"

REPRESENTATIVES AVAILABLE

ENGINEERING SALESMAN, 12 years selling manufacturers and further engineering background with industrial plants, desires to represent high-class product in New England territory. Address CA-435, care of "Mechanical Engineering."

ESTABLISHED SALES ENGINEER solicits correspondence with manufacturers of meritorious products to represent them in the New England States. Address CA-420, care of "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

E. G. Stroud, Member A.S.M.E., President The Cleveland Engineering Agency Co., 219 Huron-Ninth Building, Cleveland, Ohio, has for 30 years been engaged in technical placement work. Employers wishing to engage Executives, Engineers, Designers, Draftsmen or other technical men are invited to use this service. Applicants available should write for blank and list of opportunities.

SALARIED POSITIONS

$2,500 to $25,000

This thoroughly organized advertising service of 29 years' recognized standing and reputation, carries on preliminary negotiations for positions of the caliber indicated above, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If your salary has been $2,500 or more, send only name and address for details. R. W. Bixby Inc., 115 Delward Bldg., Buffalo, N. Y.

It will pay you to watch the announcements on this page for an opportunity that you may be looking for or one that may be of interest to you.

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American Telephone & Telegraph Co.. N. W. Ayer & Son, Philadelphia, Pa.
Bakelite Corp.... Rickard & Co., New York, N. Y.
Barnes-Gibson-Raymond.... Davis Press, Worcester, Mass.
Chas. Bruning Co.... Buchen Co., Chicago, Ill.
Philip Carey Co.... S. C. Baer Co., Cincinnati, Ohio
Climax Molybdenum Co.... Donahue & Coe, New York, N. Y.
Cochrane Corp.... Willard G. Myers, New York, N. Y.
Crane Co.... Buchen Co., Chicago, Ill.
Curtis Pneumatic Machinery Co.... Gardner Adv. Co., St. Louis, Mo.
Darnell Corp.... Henry L. Rhea Adv. Agency, Long Beach, Calif
De Laval Steam Turbine Co.... George H. Gibson Co., New York, N. Y.
Ethyl Gasoline Corp.... Batten, Barton, Durstine & Osborn, New York, N. Y.
Federal-Mogul Corp.... Fred M. Randall Co., Detroit, Mich.
Fiske Bros. Refining Co.... Chas. Dallas Reach Co., Newark, N. J.
Garlock Packing Co.... Hutchins Adv. Co., Rochester, N. Y.
Guardian Electric Mfg. Co.... Kennedy & Co., Chicago, Ill.
Heating & Ventilating Exposition.... O. S. Tyson & Co., New York, N. Y.
Hyatt Bearings.... Campbell-Ewald Co., New York, N. Y.
International Nickel Co.... Marschalk & Pratt, New York, N. Y.
Johns-Manville.... J. Walter Thompson Co., New York, N. Y.
W. A. Jones Fdry. & Mch. Co.... Kreicker & Meloan, Chicago, Ill.
Lincoln Electric Co.... Griswold-Eshleman Co., Cleveland, Ohio
Lovejoy Flexible Coupling Co.... Merrill Symonds Adv. Service, Chicago, Ill.
Marlin-Rockwell Corp.... Everett L. Bowers, Buffalo, N. Y.
Norma-Hoffmann Bearings Corp.... L. I. Wightman, New London, Conn.
Philadelphia Gear Works.... R. E. Lovekin Corp., Philadelphia, Pa.
Frederick Post Co.... Western Adv. Agency, Chicago, Ill.
J. E. Rhoads & Sons.... R. E. Lovekin Corp., Philadelphia, Pa.
John Robertson Co.... R. E. Lovekin Corp., Philadelphia, Pa.
Spring Washer Industry.... Neisser-Meyerhoff, Chicago, Ill.
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B. F. Sturtevant Co.... Rickard & Co., New York, N. Y.
Taylor Forge & Pipe Works.... Kreicker & Meloan, Chicago, Ill.
The Texas Co.... Buchanan & Co., New York, N. Y.
Tube-Turns, Inc.... Doe-Anderson Adv. Agency, Louisville, Ky.
United States Steel Corp.... Batten, Barton, Durstine & Osborn, New York, N. Y.
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